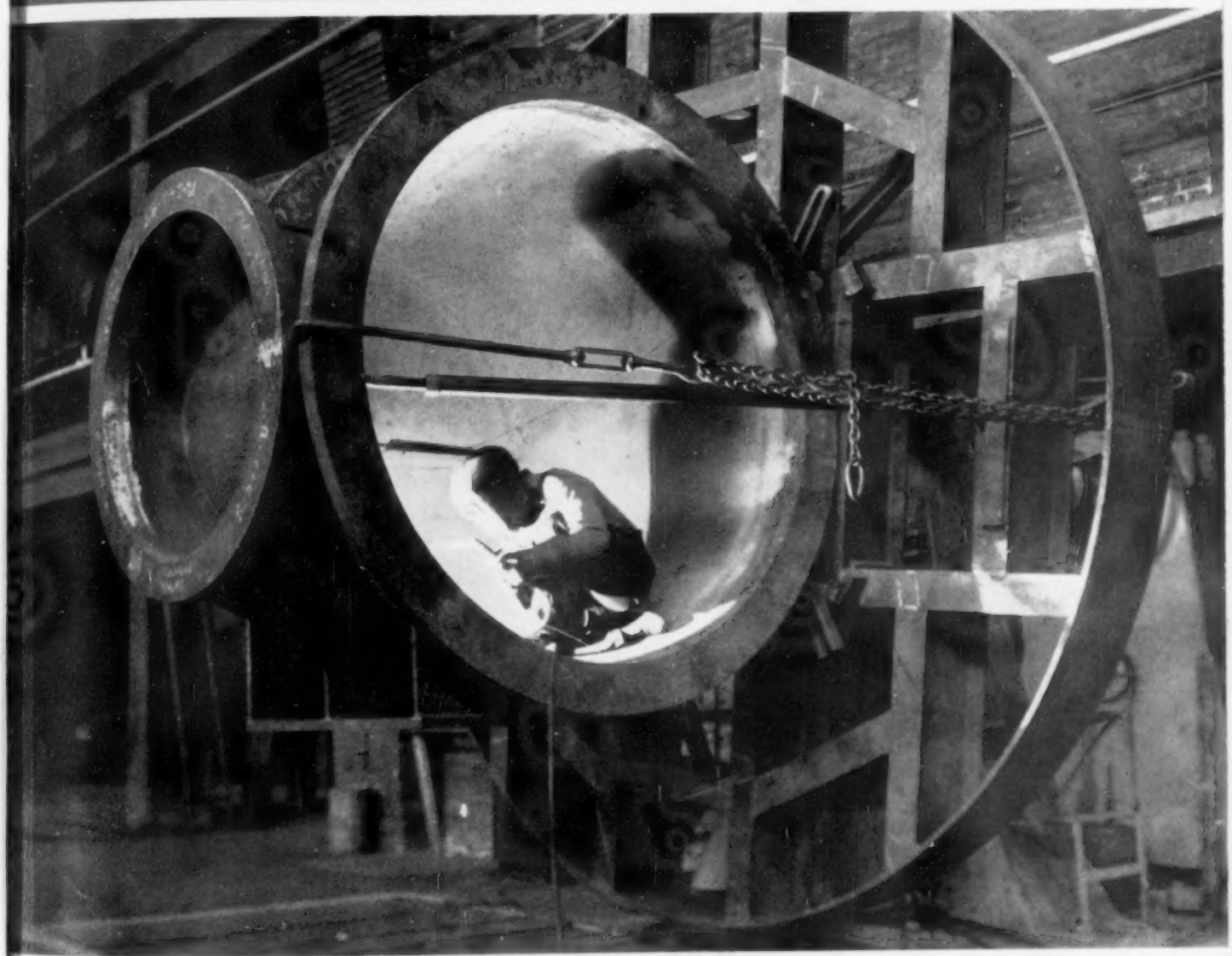
MAY 1944

MAY 23 1944

The WELDING Journal



The Journal of the American Welding Society

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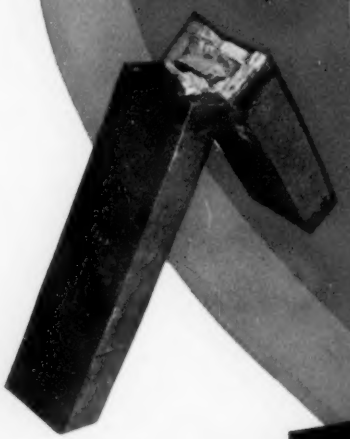

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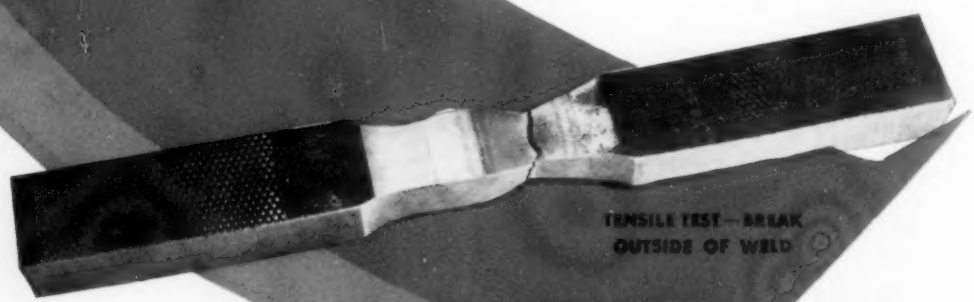

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MAY, 1944

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COVER

Bodies Fabricated by Welding for Conical Plug Type Valve.
Courtesy S. Morgan Smith Co.

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VOLUME 23 • NUMBER 5 • MAY, 1944

Welding Sequence in Shipbuilding*

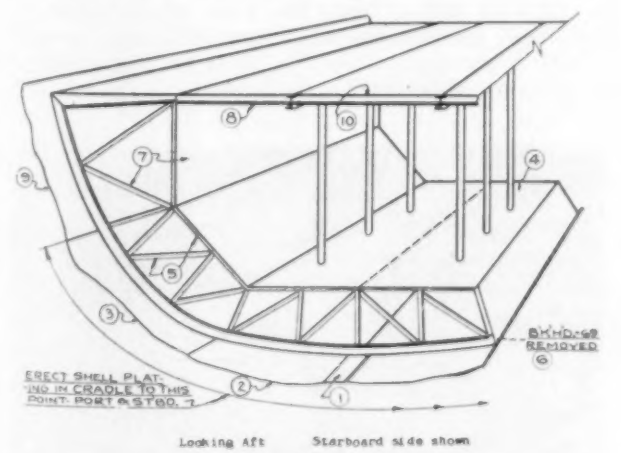
By Milton Forman†

Expansion in Ship Welding

THE present war against Fascism and Aggression has placed a tremendous responsibility on the shipbuilding industry and particularly the welding end of it. The need for the more rapid building of ships was placed before those active in the field. That responsibility was accepted by them and the proposed quota for ships was fulfilled and overfulfilled. In this great haste to build ships, welding progressed by leaps and bounds. The shortcomings and mistakes, which in normal times would not present themselves very sharply and would be solved and corrected in due time, became glaring and called for immediate solution. The problems were posed not for an individual yard competing with other yards, but as one to be solved by all shipbuilders. The responsible leaders in the ship welding field tackled and licked most of these problems. The most dramatic expression of these shortcomings, of course, is expressed in fractures and all forms of distortion.

Welding practices have been thoroughly examined and systematized. Proper welding sequences have been developed and the science of welding has been brought down to a finer point. In this sense, we can be thankful for the spurt and rapid development that this war brought to the welding field.

* Presented before Jan. 18, 1944 Meeting, Toledo Section, A.W.S.
† Welding Engineer, Toledo Shipbuilding Co.



LEGEND

	DESCRIPTION OF SECTIONS		
1	FLAT KEEL	6	BKHD. NO-69
2	'A' STRAKE SHELL PL.	7	PRE-ASSEMBLED WING TANK
3	'B' STRAKE SHELL PL.	8	2ND DK. PL. TO BE TW. OB GIRDR & LONG'L WING TK. BKHD
4	PRE-ASSEMBLED INNER BOTTOM	9	'C' STRAKE SHELL PL.
5	PRE-ASSEMBLED SLOPE TANK	10	2ND DK. PLATING-CENTER LINE

Fig. 1—Erection Sequence for Typical Main Berth

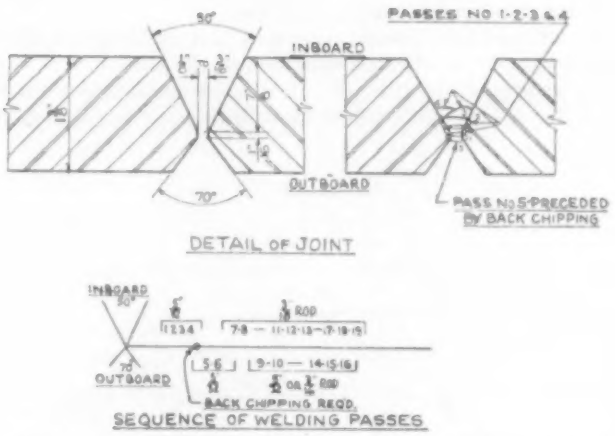


Fig. 2—Bevel Design for $1^3/_8$-In. Plating and Sequence of Welding

Peacetime will find that the shipbuilding industry is well prepared to continue the building of finer and stronger ships.

Scope of Welding Engineering

Our experience has shown that in order to produce welded ships of the highest quality, the following must be done:

1. A proper and carefully prepared welding sequence has to be prepared.
2. The practical methods of carrying out this welding sequence have to be clearly defined and properly applied.
3. The sequence and good welding practice have to become the property of, first, the supervisors, and second, the welders themselves.

In the past, a job was turned over for welding with the words, "Do It." Now, it has to be done in a certain way and the reasons must be clear if it is to be executed properly.

It is my opinion that the working out of a welding sequence should not begin after the erection and fitting plans are completed. The welding sequence should be conceived at the same time as the size and character of the preassembled sections are planned. For that matter, more attention could be paid by the designers and naval architects to the problems of welding, and I am sure that many problems of distortion could be solved merely by a change of design. In other words, a good welding sequence must be a *detailed fabrication*, *erection* and *welding* sequence.

Welding Sequence and Production

The production schedule for the completion of the job can and should be a factor in deciding the welding sequence. I believe that by this time we are aware that there may be two or more adequate welding sequences for one job, and one could use more welders and could be divided into more than one unit of operations, dependent upon the time needed to complete the job and the number of fitters and welders available.

Sequence for "Mackinaw"

In relation to the above, I want to point out the specific application of a welding sequence to a rather complex type of ship such as the heavy ice breaker "Mackinaw" which we are building here at the Toledo Shipbuilding Co. The shell plating varies from $1^3/_8$-in. plating to $1^5/_8$-in. plating. The frames are 16 in. apart. The longitudinal members are few.

A detailed fabrication, erection and welding sequence was prepared for the construction of the ship.

In approaching the job, it was immediately evident that the design lent itself very well to large preassembled

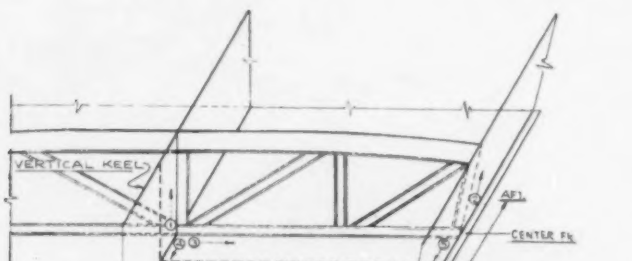


Fig. 3—Welding Sequence for Typical Innerbottom

(*a*) Weld No. 1, frames to vertical keel using skip-weld method.
(*b*) Weld No. 2, frames to longitudinal girder No. 1, using skip-weld method.
(*c*) Weld No. 3, frames to tank top using skip-weld method, starting at vertical keel, progressing outboard and make welds Nos. 4 and 5 as encountered between frames.
(*d*) When welding is completed, weld outboard fillet where longitudinal No. 1 meets tank top. Start in center and backstep progressing forward and aft.

sections. In addition, the use of these large preassembled sections would not only help speed production, but also would help cut to a minimum locked-up stresses in the final structure.

The entire sequence was prepared in a very detailed fashion. It divided the ship into thirty-three berths and a sequence was prepared for each berth. This included: 1. The size and character of the preassembled sections, 2. The method of fitting and welding of all the component parts of these sections, 3. The order of erection (Fig. 1), 4. Detailed instructions on strongbacking for the heavy plating, 5. Detailed instructions on welding each preassembled unit, 6. The welding of these sections on the hull.

The basic rules that were to be followed in welding were:

1. All boundaries were to be left free until all possible contraction had already taken place.
2. All welding was to be completed as encountered.
3. All welding was to be either backstepped, skip welded or wandered.
4. All welding would be done with stringer beads.

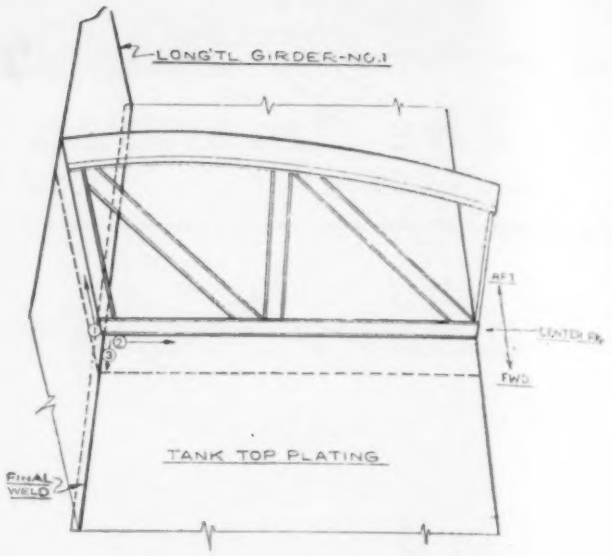


Fig. 4—Welding Sequence for Typical Slope Tank

(*a*) Weld No. 1, frames to longitudinal girder No. 2 using skip-weld method.
(*b*) Weld No. 2, frames to the slope tank top using skip-weld method starting at longitudinal girder No. 2 and progressing to edge of plate.
(*c*) Weld No. 3, longitudinal girder No. 2 to slope tank top as it is encountered between frames using backstep method.
(*d*) After weld No. 1 is carried far enough ahead, welds Nos. 2 and 3 may be made.

Detailed prints were prepared illustrating all beveled designs and the manner in which welding was to progress.

Shell Plating

The shell butt joints were designed to be double beveled, using a shoulder $^3/_{16}$ in. below the central axis. Three layers of beads would be welded so that there would be an equal amount of metal above and below the central axis of the plating. The outboard side would be backchipped and two passes deposited. Then all welding was to progress equally on both inboard and outboard sides of the plating so that the completed job would be true to the molded line. If the plating tended to distort in one direction or the other, peening would be used on the side at which the contraction of the deposited metal was acting to distort the joint away from the molded line, and more metal would be deposited on the opposite side. When the joint was brought back into proper position, the welding would progress equally on both sides again. (See Fig. 2 for beveled design and the sequence of depositing the beads.)

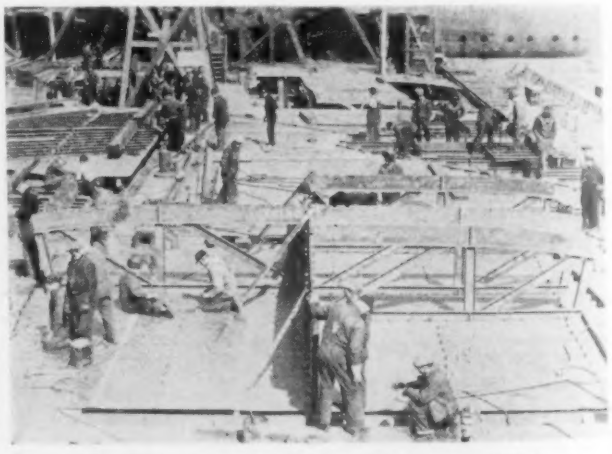


Fig. 5—Manner of Fitting Innerbottoms on Slab

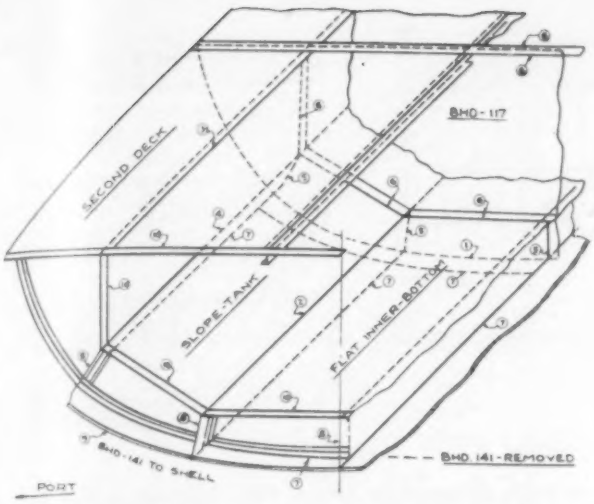


Fig. 6—Welding Sequence for Typical Berth. Berth 2—Looking Forward. Port Side Shown—Starboard Similar and Opposite. Weld Nos. 5 through 10 Are to Be Made Simultaneously in Berths 1 and 2

Note that shell welding is completed through the "B" strake before welding of internal structure begins. Also, the internal structure within the berth is completely welded into one unit before it is attached to bulkhead. Then welding of frames to shell begins, starting at midships bulkhead and progressing forward and aft.

Because of the heavy plating, the usual method of pulling the plating to the framing was impractical. A cradle was built and the shell plating up to and including the "B" strake was set and welded to conform to the molded line. Then the erection of the internal structure was to begin.

The shell plating was joined in the following manner. The transverse butts of the flat keel would be welded first in order to make the flat keel one unit so that it corresponded in length at least to the berth being welded. The transverse butts of the "A" strake were then welded. (This included from four to five plates for a berth.) A berth was defined as including two major structural watertight bulkheads up to and including the second deck. When these were complete, the "A" strake was joined to the flat keel simultaneously on port and starboard sides. Four welders were used on each side, and the

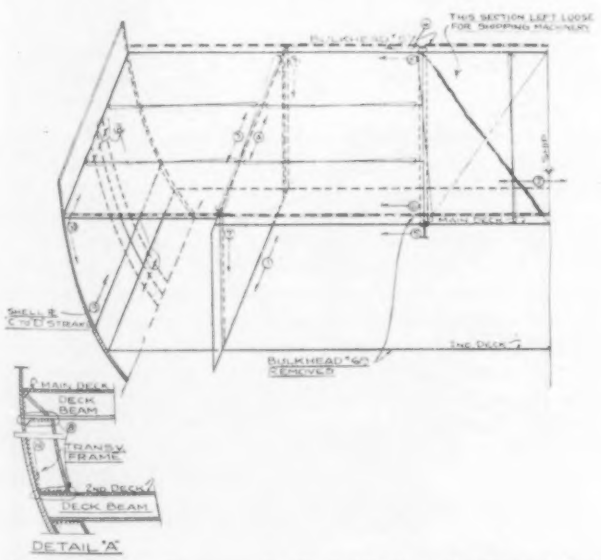


Fig. 7—Welding Sequence for Berth 19 Above the Second Deck

(a) Welding to proceed on port and starboard sides simultaneously.

(b) Numbers encircled indicate sequence of welding. For procedure see written sequence.

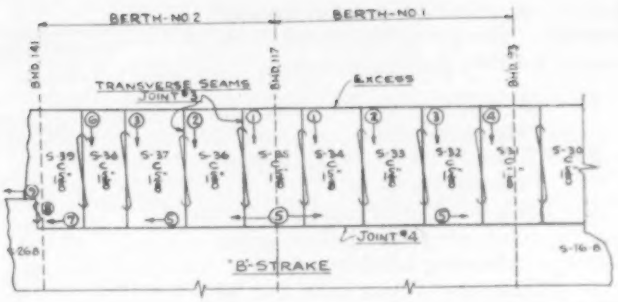


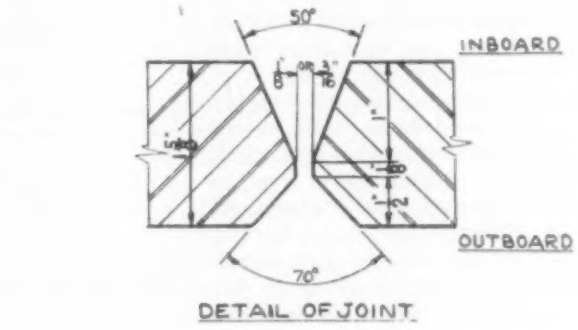
Fig. 8—Welding Sequence for "C" Strake Midships. Shell Plating—"C" Strake. Frames 93 to 141. Starboard Side Looking Inboard

(a) Welding to proceed on port and starboard simultaneously.

(b) Numbers encircled thus ○→ indicate welding sequence.

(c) Details for joints Nos. 3 and 4 are shown on drawing.

(d) Weld No. 5 to be made with 4 men, 2 welders start at bulkhead 117, progressing forward and aft using backstepping method. One man starts at frame 105 and backsteps progressing forward, one man starts at frame 127 and backsteps progressing aft.



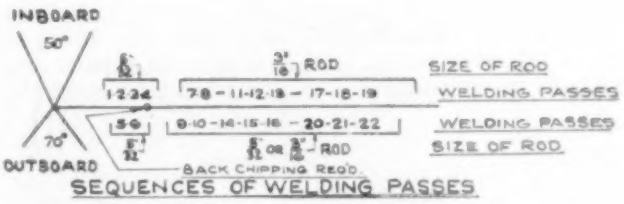
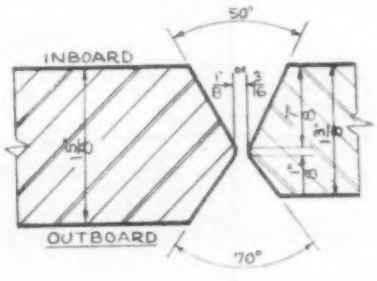


Fig. 9 (a)—Type Joints No. 3—"C" Strake Plate Butts



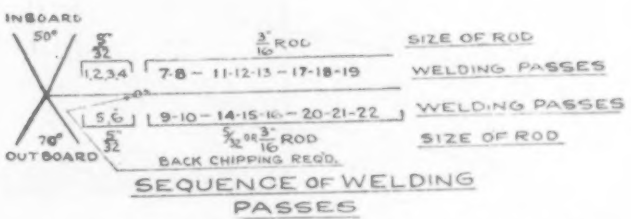


Fig. 9 (b)—Type Joint No. 4—"B" and "C" Strake Plate Butts

length of the seam was divided equally. A copy of the instructions issued for this welding follows:

1. All welding to be done in stringer beads.
2. All beads to be backstepped, maximum 14 in.
3. Each bead to be completed to end of plate before each following bead is welded.
4. Minimum of four passes to be welded inboard before backchipping.
5. All backchipping to be carried to clean metal at all points.
6. All butts to be checked so that they are faired up properly at all points before welding.
7. All butts to be checked periodically with a proper template for distortion, to guarantee that plates follow the correct curvature when welding is completed.
8. All slag to be thoroughly cleaned from weld before following bead is deposited.
9. Plates to be left free to move for weld contraction. Strongbacks not to be tacked to more than one shell plate.
10. All shell plates are to be fitted for fairness with inboard side as the flush side.

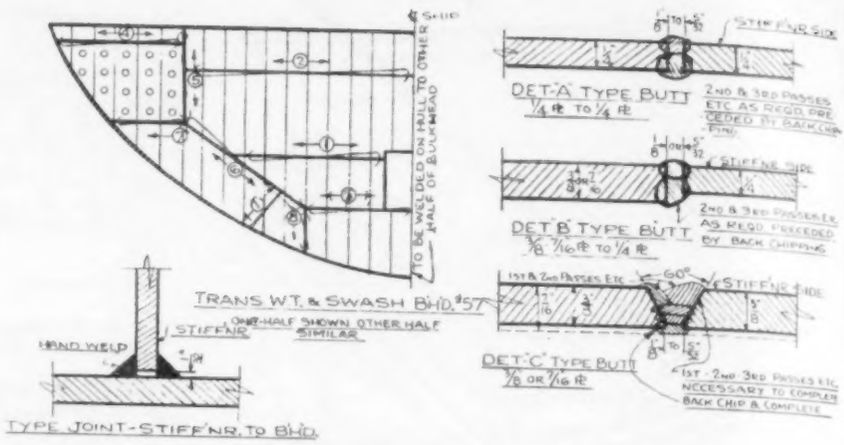


Fig. 10—Welding Sequence for Typical After-Bulkhead

(*a*) Numbers encircled thus ⓘ indicate the sequence and direction of welding.

(*b*) Seams are to be faired up and tacked; bridge to be placed across seam.

(*c*) All welding of plate butts to be backstepped with 6-in. increments. Complete stiffener side first.

(*d*) Weld stiffeners using skip-weld method. Welding to start at mid-point of assembly and progress toward ends. Stiffeners to be welded from center of assembly to outer boundaries.

(*e*) When bulkhead is turned over, plate seams are to be backchipped and welded. Use backstep method in same sequence as shown on diagram.

Preassembly.

The preassembled sections were built on a fitting slab in the following manner. Let us use the typical innerbottoms as an example. The material in the innerbottoms included tank top plating, vertical keel and longitudinal girder No. 1, and framing. The tank top plating butts were completely welded first in a special sequence which conformed with the design of the plating. Then, the vertical keel, frames and longitudinal girders were placed in their proper places. Then, in order to break down the welding so that all the vertical welding could be done at one time without the continuous change from all

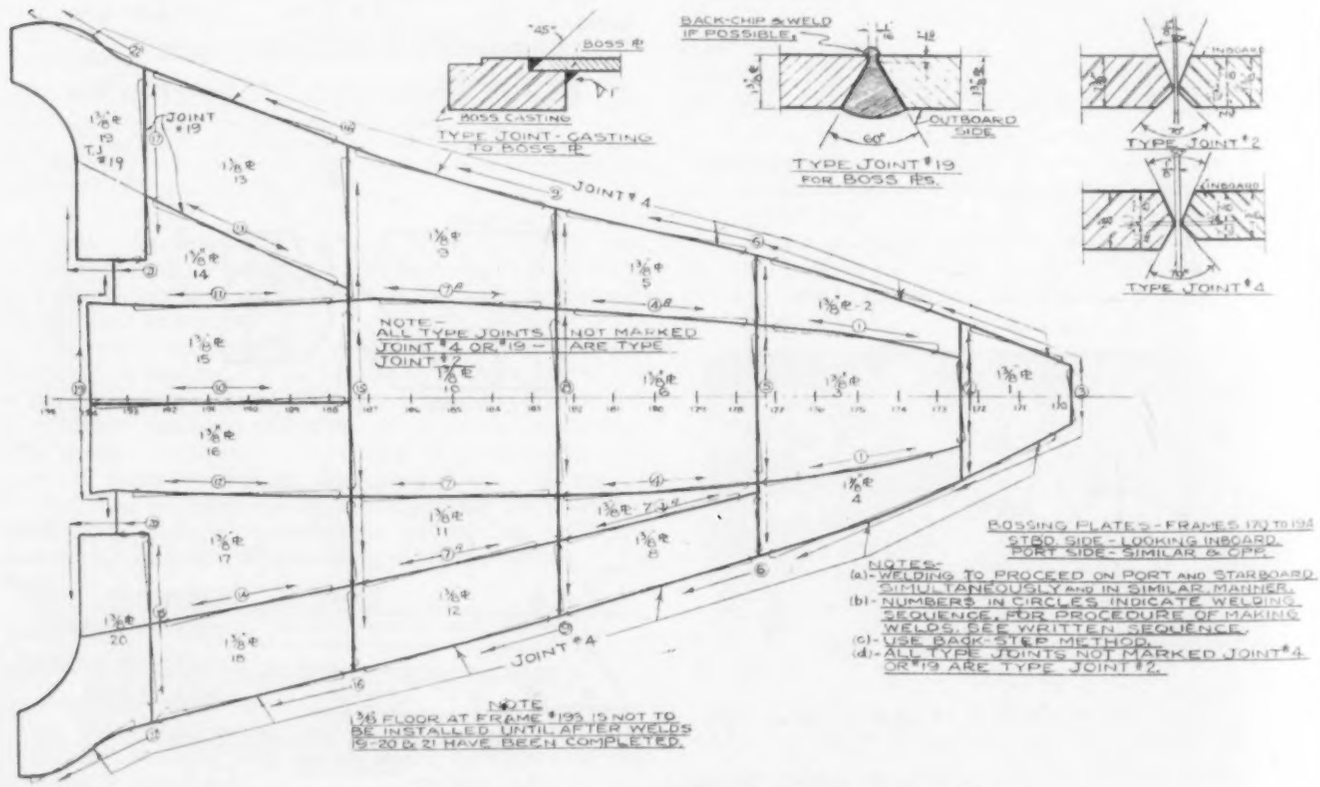

BOSS CASTING
TYPE JOINT - CASTING TO BOSS PC
BACK-CHIP & WELD IF POSSIBLE
TYPE JOINT #19 FOR BOSS PCS.
TYPE JOINT #2
TYPE JOINT #4
JOINT #4
NOTE - ALL TYPE JOINTS NOT MARKED JOINT #4 OR #19 - ARE TYPE JOINT #2
BOSSING PLATES - FRAMES 170 TO 194 STBD SIDE - LOOKING INBOARD. PORT SIDE - SIMILAR & OPP.
NOTES:-
(a) - WELDING TO PROCEED ON PORT AND STARBOARD SIMULTANEOUSLY AND IN SIMILAR MANNER.
(b) - NUMBERS IN CIRCLES INDICATE WELDING SEQUENCE. FOR PROCEDURE OF MAKING WELDS, SEE WRITTEN SEQUENCE.
(c) - USE BACK-STEP METHOD.
(d) - ALL TYPE JOINTS NOT MARKED JOINT #4 OR #19 ARE TYPE JOINT #2.
NOTE
1/2 FLOOR AT FRAME #193 IS NOT TO BE INSTALLED UNTIL AFTER WELDS 19-20 & 21 HAVE BEEN COMPLETED.

Fig. 11—Welding Sequence and Beveled Design—Boss Plating

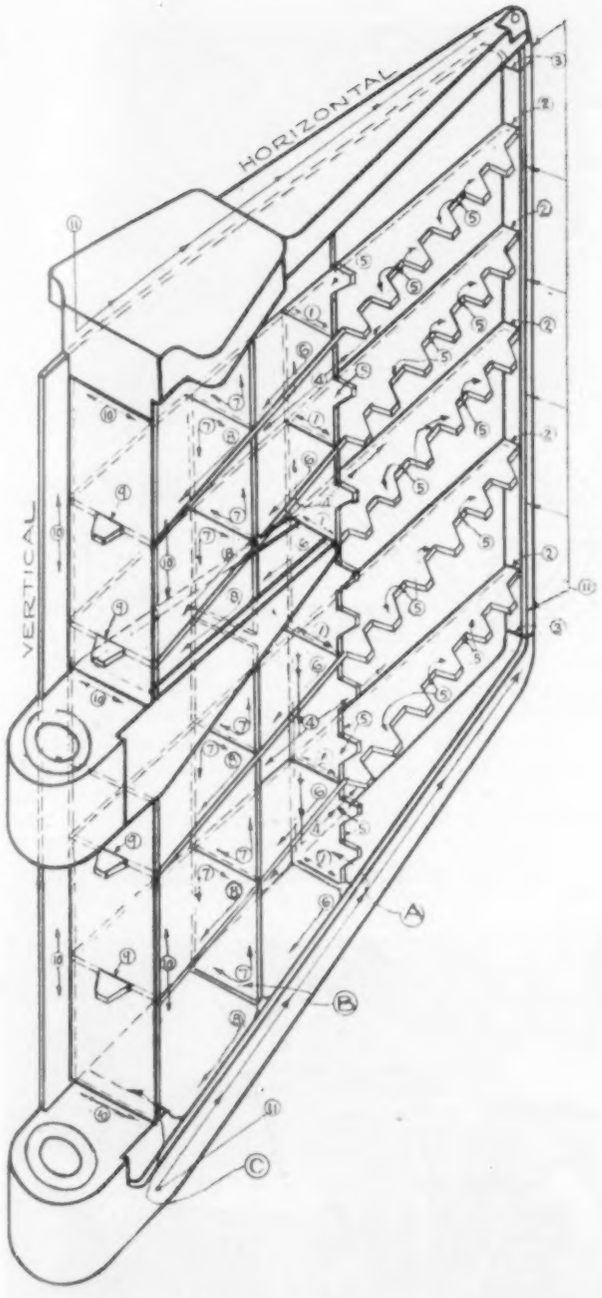


Fig. 12—Welding Sequence for Rudder

(*a*) Weld (1) horizontal webs and center steel casting to vertical webs (*A*).

(*b*) Weld (2) horizontal webs to vertical forging.

(*c*) Start at center of vertical web and progress to ends, for welds (1) and (2).

(*d*) Weld (3) vertical forging to top and bottom steel casting.

(*e*) Fit $1^3/_8$ plate on side opposite pull-up lugs. Weld (4) horizontal webs, steel castings and forging to $1^3/_8$ plate. Start at center of assembly and progress to extremities. Use skip-weld method.

(*f*) Fit $1^3/_8$ plate to pull up lug side. Bevel slots at lugs. Weld (5) slot welds. Start at center of assembly and progress to extremities. Weld in accordance with Fig. 13.

(*g*) Weld (6) horizontal webs to $1^3/_8$ plate on pull-up lug side. Start at center and progress to extremities and up to vertical web (B).

(*h*) Fit vertical web plates (*B*) and weld (7) to both $1^3/_8$ plate and horizontal webs and castings from forward side only.

(*i*) Complete horizontal webs and steel castings to $1^3/_8$ plate on pull-up lug side by welding (8).

(*j*) Fit vertical webs (*C*) and weld slots in similar manner to (*f*).

(*k*) Weld (10) using wandering method. Weld upper and lower halves simultaneously welding from forward side only.

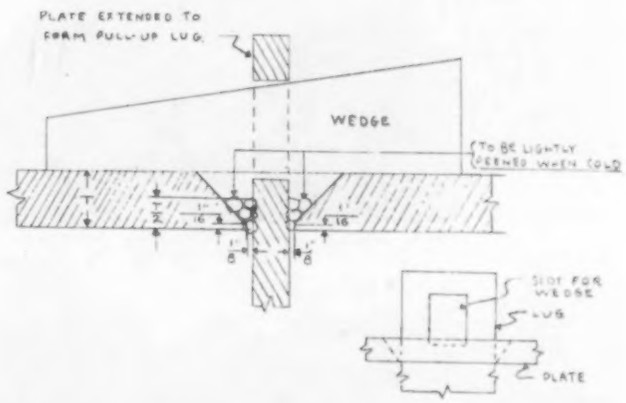
(*l*) Weld (11) $1^3/_8$ plate to steel castings and forging. Use staggered intermittent method, welding port and starboard and top and bottom sides simultaneously. Progress in direction shown. Complete each pass before starting following one.

(*m*) Lightly peen all layers of weld to castings except the first and last layers.

position to down-hand rod as the welding progressed from one frame to the other, the vertical welding was completed first. Skip weld method was used. All welding started at the center frame and progressed forward and aft. The welding on the vertical keel slightly preceded the welding on the longitudinal girder No. 1. After all the vertical welding was complete, the framing and the girders were finally adjusted to the tank tops and tacked. The welders changed to down-hand rod and welded the structure to the tank top in a manner similar to that described above. The longitudinal members were welded to the tank top as encountered between frames. Special care was taken in welding the watertight boundaries (see Figs. 3, 4 and 5).

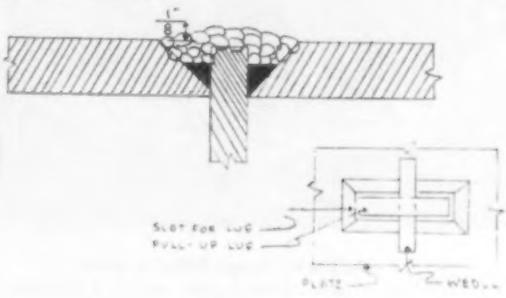
Hull Erection and Welding

After the "A" and "B" strakes of this heavy, rigid shell plating were completely welded to each other, all the structure in the berth was erected including the two bulkheads and the second deck. First the innerbottoms were welded to the slope tanks in the proper sequence, then the slope tanks were welded to the wing tanks. In other words, the internal structure was joined into one large section before it was attached to either bulkhead or to the shell (see Fig. 6). Then these large sections in the forward and after berths were attached simultaneously to the midship's bulkhead. Then and only then were the frames finally adjusted to the shell and tacked. When all the tacking in the berth was complete, all holding down gears and saddles, etc., were removed to make the welding in these tight tanks as convenient as possible for the welders. The welding of the frames to shell



STEP I

Weld lower half of groove as shown above. Remove wedge and turn off pull-up lug approx. $^1/_8$ in. below flush line of plate. Peen weld lightly when cold.



STEP II

Complete weld as shown above.

Fig. 13—Weld Joint—Plating to Pull-Up Lugs

Fig. 14—Welding Sequence for Forward Shaft Tube

(a) Weld port and starboard seams simultaneously.
(b) Use backstep method.
(c) Start first pass at center and backstep to ends. Start second pass at ends and backstep to center. Alternate all passes in this manner until welding is complete.
(d) Fit bearing ring to tube and weld. Use wandering sequence welding inboard and outboard simultaneously.
(e) Type joints are indicated above.

began at the midship's bulkhead and progressed simultaneously forward and aft, port and starboard, using the skip-weld and backstep methods completing all longitudinal welding as encountered. Note that the intent of this sequence is to allow all welding to take place in an unrestricted manner so that there be very little pull on the bulkheads as a result of the contraction and no locked-up stresses developed on the shell while the internal structures were being welded to each other. This welding proceeds in the forward and after berths

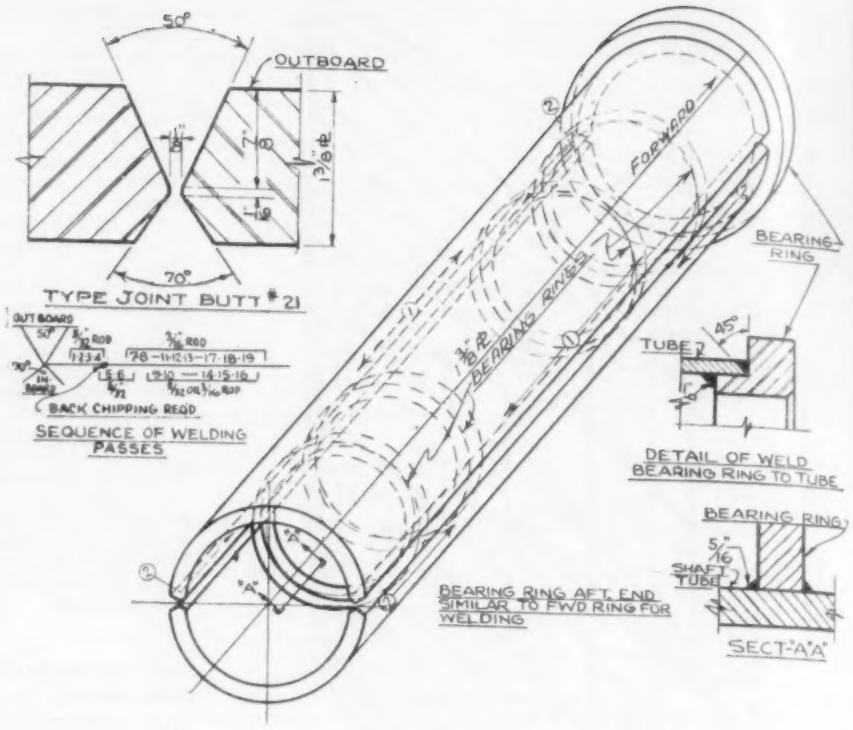


Fig. 15—Forward Shaft Tube Complete
Note that completed job left tube precisely round.

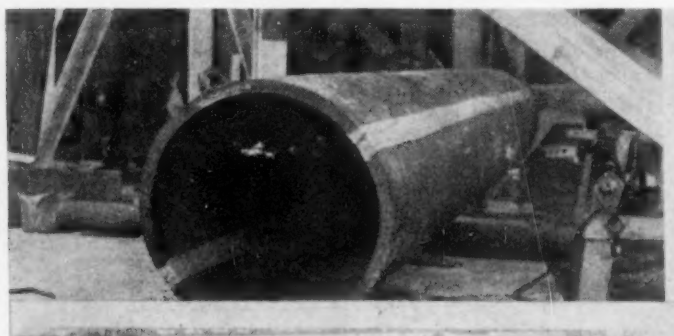


Fig. 16—Rudder in Process of Being Built

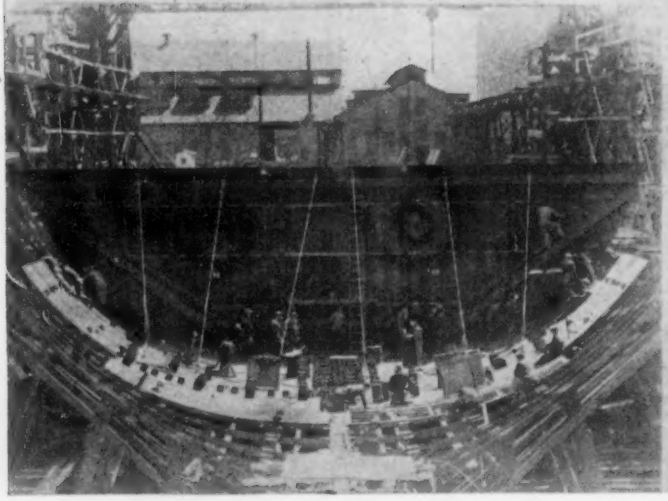


Fig. 17—Bulkhead Being Fitted to Shell
Note that curvature of shell plating after welding has been completed must conform with the molded line of the bulkhead since adjustment of bulkhead to shell must be kept to a minimum because of the impracticability and inadvisability of forcing heavy plating to bulkhead.

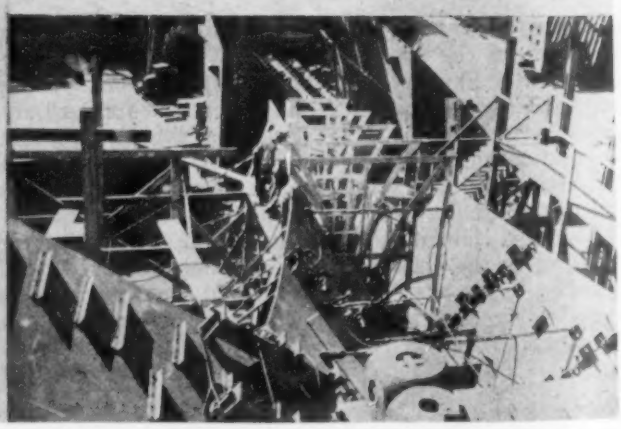


Fig. 18—"A" Strake of 1 3/8-In. Plating Being Fitted on Ship
Note that they must be brought into perfect position to conform with template before welding begins and they must remain so after welding is complete. The template shown here used until the job was complete.

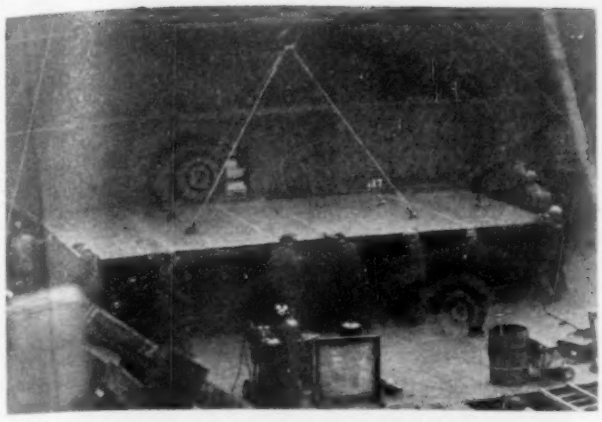


Fig. 19—Innerbottom Being Erected on Shell
Note that innerbottom must fit this heavy shell very well without resorting to large scale fairing up if major stresses are to be avoided.

in a similar manner, progressing at all times toward the open ends (see Fig. 7).

After the above was completed, the $1^{5}/_{8}$-in. "C" strake was erected and welded. Special care had to be taken that the frames were not tacked to the "C" strake while the shell butts (see Fig. 8) were being welded; and excess had to be left on every fourth transverse plate to account for contraction of the butt welding. The frames were then welded to the "C" strake in a similar manner to the other framing with the exception that all welding started at the second deck and was backstepped, progressing downward, toward the longitudinal girder No. 2. The above is the welding sequence for Berth 1. There are thirty-two more berths in the ship, some are more complex, some are less complex. They are erected and welded with the same basic principles applied.

Specific instructions and sequence were prepared for every particular job such as the bulkheads, shaft tubes, the boss plating, rudder, etc. (see Figs. 10–12, 14–16).

Welding Sequence to Be Properly Executed

The best welding sequence, if it remains on paper and if it is not properly executed, is as good as none at all. The welding engineer and supervisor must be alert at every stage of the building of the ship, looking ahead at all times in order to guarantee that the sequence is properly executed and, if necessary, changed. Problems develop in the most properly planned sequences that must be licked in the development of the ship—problems of production; problems where the sequence is not carried out and it is inadvisable to chip out all the welding that has been done. At this time, the new situation must be reanalyzed and the ways and means found for completing the job with a minimum amount of locked-up stresses under the conditions. Thorough inspection systems must be in effect through either the supervisory staff or inspectors, to guarantee that the quality of the work in the carrying out of the sequence is high. Where a crack is found, the welding supervisor must guarantee that it is completely chipped out before futher welding progresses and then, that it is welded with special care and in a special manner. The welders themselves, who are best situated to detect defects in workmanship, should be encouraged to point out defective work instead of covering it up.

Quality of Ship Fitting

The best sequence applied to a job that is poorly fitted cannot give good results. Numerous building-up jobs and bad fits destroy the intended results of a good welding sequence. Sections that have to be faired up and fitted under terrific strain will give rise to unsatisfactory conditions and will cut down the strength of the completed job. This, of course, is especially true when you are dealing with such heavy shell plating as we had on this ice breaker. The welding of castings and other special structures that make up the ship must be handled individually with the proper use of heat and peening.

Conclusion

Welding engineering has long passed the point where it is blind and experimental. The basic factors are already known, and if the job is carefully and properly analyzed, the proper results can be achieved. But these results can only be achieved if the instructions are properly transmitted to the men supervising and doing the work. There should be no job or problem too small that it is not analyzed by the welding engineer, and then that he patiently presents it to the supervisor for execution.

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Atomic-Hydrogen Arc Welding in Aircraft Production

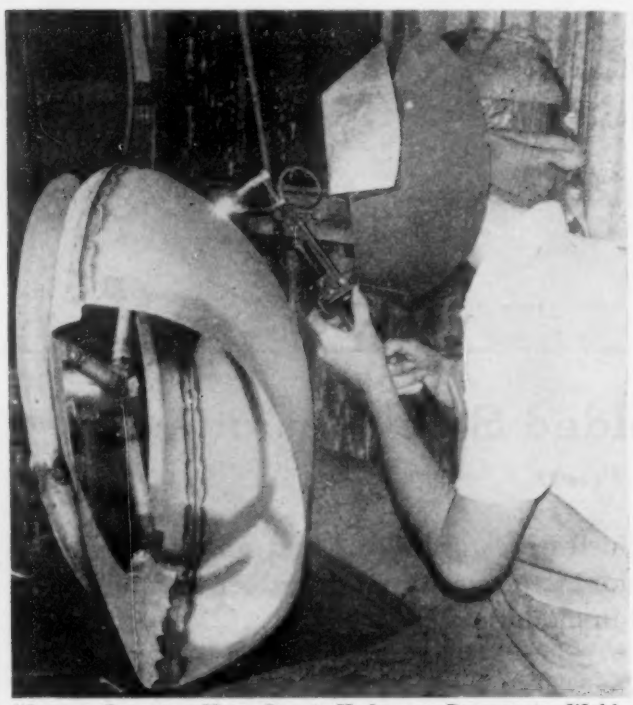
By Wm. J. Van den Akker*

NO PROGRAM like the present war effort in which the United States is engaged—in fact, no program in history—has ever so completely marshalled the industrial power and ingenuity for which this country in its mass-production achievements has so long been the outstanding example. In every phase of manufacturing, war industry has been tireless in its efforts to uncover faster and more "fool-proof" methods for the fabrication of the war goods so vitally needed.

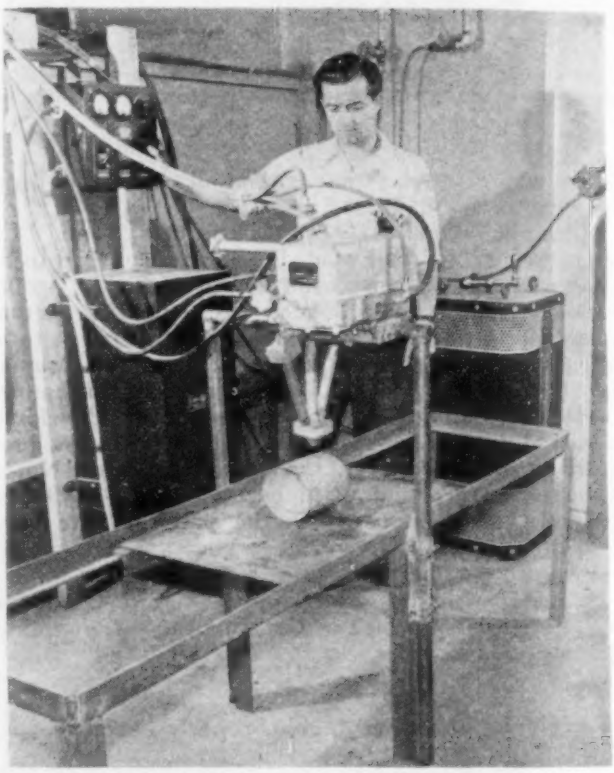
In this respect, the field of welding has not been lacking; tremendous strides have been made. Notable examples are the welding of cargo ships, the recent development of a satisfactory method of welding magnesium, improved welding machines, improved welding electrodes, and a fuller knowledge of the metallurgical characteristics of the weld structure. Failures in welds are now more the exception, and the reason for the few failures that do occur can generally be identified quickly and easily.

One phase of this industrial achievement has been in the field of the welding of light-gage materials used in the aircraft industry. Here progress can largely be measured in the fuller utilization of existing welding facilities coupled with an increased knowledge of welding design as well as of the metallurgical characteristics of the special alloys used in this type of work.

* Assistant to Production Superintendent, Ryan Aeronautical Co.



Woman Operator Uses Atomic-Hydrogen Process to Weld Large Thin Shell of Stainless Steel. Distortion Is Held to a Minimum

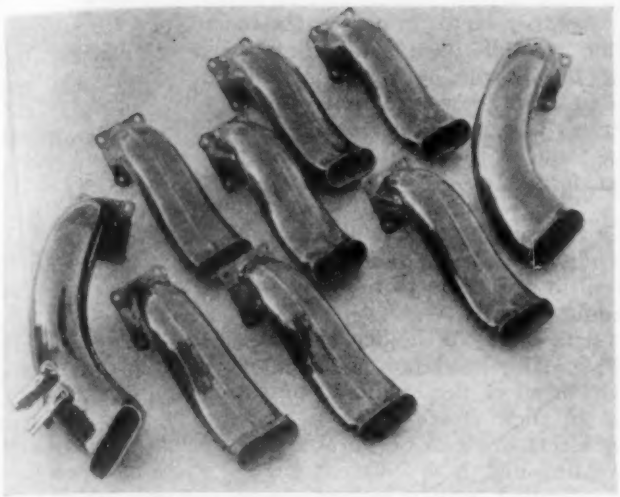


Automatic Atomic-Hydrogen Arc-Welding Equipment Used at the San Diego, Calif. Plant of the Ryan Aeronautical Company

At the Ryan Aeronautical Co., early use was made of the atomic-hydrogen arc-welding method. This process had not previously been used to any appreciable extent for the welding of light gages of stainless steel in the fabrication of exhaust collectors, heat exchangers, etc., although it had advantages over other processes which had been known for some time. The methods previously used for the majority of the work possessed inherent disadvantages particularly harmful to both the ductility and corrosion resistance of this material.

In the case of stainless steel, these disadvantages consisted of carbon pickup, generally resulting from the use of excess acetylene, together with a longer welding time which resulted in a partial loss of the stabilizing elements of columbium and titanium. These elements stabilize the alloy and prevent an inter-crystalline breakdown when the finished product is subject to high service temperatures.

It was obvious at the outset that the atomic-hydrogen method would overcome these two major objections. With the use of hydrogen, which in many respects is the opposite of oxygen, a reducing atmosphere is present so that any "burning" or severe oxidation, with its resultant ill effects, is not so difficult a problem. In addition,



Finished Low-Carbon Steel Parts After Enameling. Parts Were Welded with Atomic-Hydrogen Arc-Welding Equipment

the heat transfer of the atomic arc is so much more rapid that the time at welding temperature is also shortened. This latter characteristic is very desirable since the corrosion resistance of the material is improved.

Resistance to corrosion is particularly necessary because of the high service temperatures to which the parts are subjected. It is a curious corollary that the ductility and corrosion resistance of the 18–8 type of stainless steel are usually closely related so that a weld of good ductility is generally corrosion resistant and vice versa.

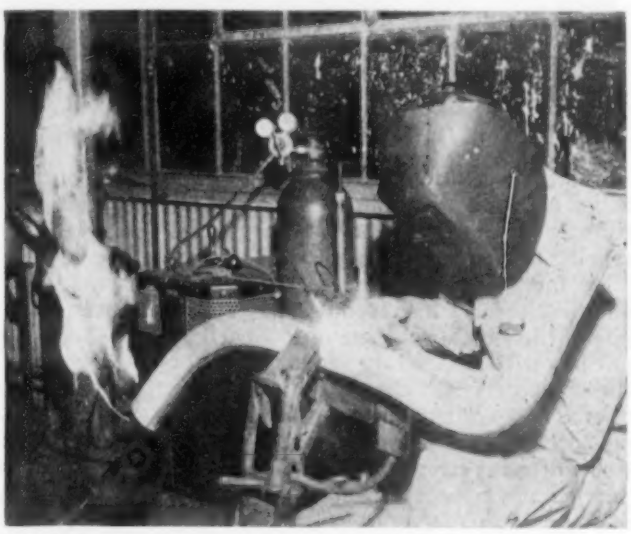
Early attempts to use the atomic-hydrogen welding process at our plant met with many of the usual stumbling blocks. Some welding operators distrusted the method, thereby slowing down shop acceptance. To others, this method's high rate of heat transfer resulted in difficulty on the part of the operator in controlling his speed. Too slow a speed would often result in a burning through, necessitating repairs and, in many instances, scrapping of the part. Too fast a welding speed resulted in severe shrinkage of the weld over its length, so that a series of cracks would form across the weld. These cracks necessarily demanded repair welding, again resulting in an unfavorable attitude on the part of the welding operators and sometimes on the part of the supervisors.

Persistence, together with a careful evaluation of the lessons learned, soon brought forth much interesting and useful information. The "silent arc," that is, the arc obtained when the electrodes are held closely together, permitted a finer control on thin gages of metal, while using the "singing arc," obtained with the electrodes separated to a greater extent, very often forced the operator to weld so rapidly that cracks would develop, caused by the severe cooling which followed as the arc passed rapidly over the molten metal.

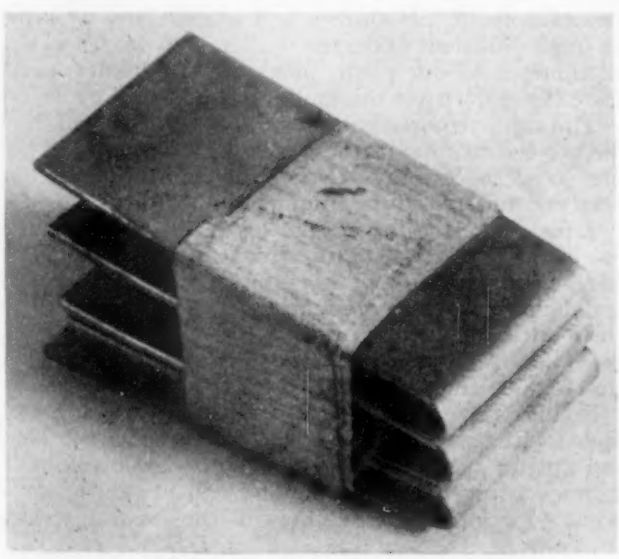
Another factor which always puzzled the technician as well as the welding operator was the formation of wormholes almost in the center of the weld, running lengthwise with the bead. This trouble, however, has been eliminated almost completely. It was caused by too rapid welding which did not give the metal time to flow flat before it became frozen.

The methods now in use with the atomic-hydrogen welding process demand a slower welding speed than was used earlier, yet this is still a little more than twice as fast as a competitive process. Also, the use of the "silent arc" has become standard because of the finer control obtainable.

Higher hydrogen pressures, as well as a higher current, are used in tacking since, as is common in most tacking operations, a high heat is required to bring the metal temperature up quickly so as to develop a small weld without distorting the assembly. Another technique found to be very advantageous is adjusting the tungsten electrodes so that the arc fan can be rotated to almost any desired angle. This flexibility permits a great range of welded joints and permits the operator to weld ill-fitting parts with more than a fair degree of proficiency.

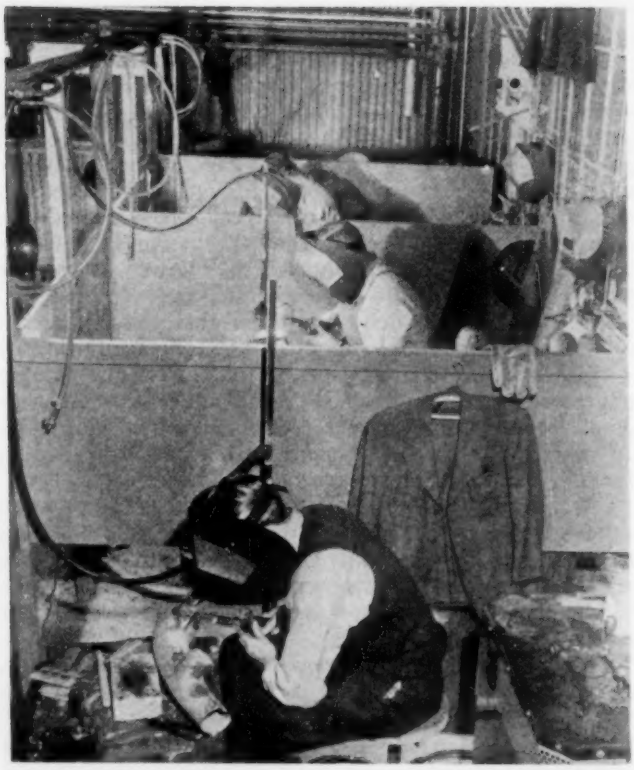


Welding a Long Irregular Section with Atomic-Hydrogen Arc-Welding Equipment. Note that One End of Section Is Plugged with Asbestos. Burning Natural Gas on the Inside of the Tubular Section Forms a Reducing Atmosphere, Resulting in a Smooth Inner Bead



Test Samples of 18–8 Stainless Steel, Atomic-Hydrogen Arc Welded. Weld Has Been Bent 180°. Note Complete Absence of Cracking

The following types of joints have been welded with this process: lap, fillet, butt, flange, seam, edge and corner. Notwithstanding the above-mentioned advantages, many of primary importance, there is still the major function of a welded joint to be considered. We may define this major function as being the final bond obtained after the weld is complete—its soundness, strength and fatigue-resistance characteristics. In this respect, the welds produced by the atomic-hydrogen



A Few of the Atomic-Hydrogen Arc-Welding Machines in Operation at the Ryan Aeronautical Company Plant, San Diego, Calif., Where They Are Used in the Fabrication of Aircraft Parts

welding process have proved superior to those of many other methods of welding and equal to the welds made by any of the methods now in general use. In many specific applications, this process is desired over others.

So far, our discussion has concerned the welding of stainless steel. This process has also been used and is now in use in the welding of low-carbon steel sheet compatible with enameling materials. For the welding of these materials, the atomic-hydrogen process has offered an excellent means of joining thin-gage materials on both irregular and closed-angle welding, resulting in welds of good strength and ductility. The welding output per operator has been materially increased because of the greater speed obtained.

This is also proving very desirable because of the narrower weld bead which is obtained. A narrow weld bead very often is desirable in aircraft welding since the soundness of the weld is more easily determined and visual inspection is made easier, together with the fact that a uniform narrow bead commensurate with adequate penetration shows a fine degree of operator control. This usually indicates that the weld metal has not been so severely overheated as to damage the material.

The cost of the atomic-hydrogen arc-welding process is lower than that of a competitive process because of the greater amount of welding which can be completed in an 8-hr. day. About one-third of a cylinder of hydrogen per operator is used daily and the electrode cost is about twenty cents.

The pressure gages used are those which are standard in the welding industry with the slight exception that the working pressure gage is graduated in 1-lb. divisions. This is not, however, absolutely essential. The electrical cost is quite low.

Another factor in cost is the matter of joint preparation. It has been found that by careful manipulation of the atomic-hydrogen arc-welding torch, ill-fitting joints can be welded quite successfully, because of the better penetration achieved. Thus, the fitting cost can be reduced with resultant saving in the over-all cost of welding.

So far we have mentioned some of the uses and techniques of the atomic-hydrogen welding process, and while literature is available on the essentials, it may be well at this time to mention a word or two about the equipment.

The electrode holder used consists of a holder into which the insulated leads enter through the handle. The head of the holder mounts two tungsten wires set at an angle of approximately 50°. The tungsten wires or electrodes can be obtained in various diameters for welding metals of different gage. These electrodes are surrounded with a hollow sleeve through which pure hydrogen is forced under comparatively low pressures, usually from 1 to 5 lb. The higher hydrogen pressures are used in tacking while the lower are used for welding.

When the arc is struck between the two tungsten electrodes, it is bathed in an atmosphere of burning hydrogen which burns with a yellowish flame while the arc itself can be identified because of its brilliant blue-white color. Helmets similar to those used in arc welding must be used to protect the eyes of the operator.

It is at this juncture that we must truly appreciate the atomic-hydrogen welding process, for the action of the electric arc dissociates the hydrogen from its common form of H_2 (molecular) to that of the H_1 or atomic form. This requires a tremendous amount of energy. However, since this energy is absorbed in breaking the hydrogen gas down to its atomic form, it is regained when this gas strikes the metal and an enormous evolution of heat results over a small area. This release of heat energy accounts for the very rapid rates of heating which are obtained. It must also be borne in mind that the atmosphere of hydrogen prevents the oxidation of either the metal being welded or of the electrodes, and accounts for the cleanliness of the resultant weld and the comparatively long life of the tungsten electrodes. It further makes the use of flux unnecessary in many welding applications.

Now that this method has been accepted and is being placed more and more into general use, a word, too, about the training of welding operators for the use of this equipment. Both men and women have proved to be quite proficient in the use of atomic-hydrogen welding machines. At our plant, plans are now under way to have the majority of this equipment operated by women.

The rigid requirements of both the Army and Navy for the certification of these welding operators has been met very successfully. No particular difficulties have been encountered in the training of operators.

A feature of the torches first used was that they were too heavy. In the majority of cases, aircraft companies engaged in this type of work have constructed smaller and lighter torches to enable women operators to use them without tiring. In some cases, a redesign of the torch has been necessary to facilitate the welding of closed-angle and narrow welds.

Because of the cleanliness of the welds which are obtained with this process and because of the narrow beads and greater speed obtained, it is felt by many that the atomic-hydrogen welding method will in the future replace, to a large extent, many of the existing welding processes.

Procedures for Testing Metallizing Bond

By H. Ingham* and K. Wilson*

[In an effort to standardize testing methods for the adherence strength of sprayed metals, the authors have worked out two procedures described in this article. One is a test for shear strength, the other for tensile strength, since both shear and tension affect bond strength. These tests are useful for controlling quality of surface preparation in production and in working out procedures on new metals and coatings.]

IT IS of great importance that standard testing procedures be developed and accepted by the metallizing industry so that consistent results can be predicted and obtained by all users, and so that results can be compared on a uniform basis throughout the country. As there are at present quite a number of different methods of bonding sprayed metal, it is obvious that more should be known about the difference in bond strength between them so that the right selection can be made for the job. Furthermore, accurate bond tests will contribute greatly to the control of any given bonding method.

With this objective in mind, these test specimens and procedures are being offered to the metallizing industry in the hope that they will eventually be accepted as standard, either as originally presented, or with any modifications that may be deemed advisable. For these test procedures to fulfill their objective, they must first prove an accurate means for comparison of different methods of bonding. Secondly, they must provide accurate values in pounds per square inch for each bonding method and for each metal used.

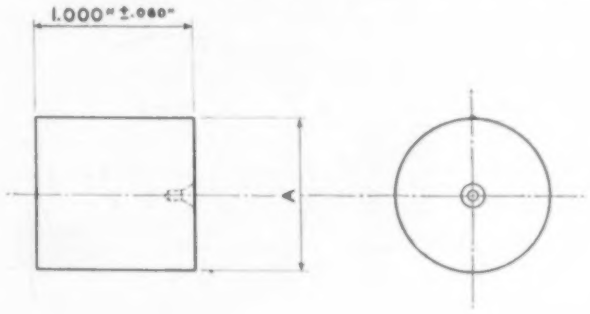
The nature of the failure of the bond between sprayed metal and base metal is somewhat complex. The most common failures occur either on flat or nearly flat surfaces, or shafts which have been cut with a keyway. In both cases most failures occur first by a shearing of the bond due to a shrinking of the sprayed metal layer. This shear action is not necessarily sufficient to cause complete failure, but may simply weaken the bond. After the bond is weakened, the final failure is a failure of the bond in tension as the sprayed metal layer is lifted off either by the curling action resulting from shrinkage or by actual mechanical means. This would depend upon the service encountered. Because this type of failure caused by the shrinkage of the metal is the most common, the strength of the bond in shear is most important. However, as both shear and tension affect the bond strength, methods for testing both have been developed.

Shear Test Specimen

The various proportions of the standard shear test specimen were decided upon after considerable experimentation. It is important that the thickness of the sprayed coating and the bonded area of the sprayed coating be so proportioned that all of the failure takes place at the bond area. If too great a bond area is presented, some of the sprayed metal may fail in compression during test. It is obvious that even the slightest failure of the sprayed metal layer will produce inconsistent results in the bond test values.

The standard bond test shear specimen is shown in Figs. 1 and 2, together with all dimensions and tolerances. It was decided to make the specimen cylindrical because this shape lends itself best to the application of all bonding methods, including those obtained by various methods of machining. The base metal is selected in the form of a bar approximately 1 in. in diameter. This is machined first throughout its length to the diameter listed in Fig. 1. The length of the specimen is given as 1 in., but this may be varied depending upon the method to be used to hold the piece for machining. The pieces may be made longer and held between centers, but it is recommended that a tapered hole be made in one end of the specimen and that it be mounted in the lathe on a tapered arbor. This method seems best adapted to removal and replacement of the piece for accurate repositioning. In any case, provision must be made for finish machining after spraying in such a way that the free end (where the numbers are stamped) of the specimen and the edges of the sprayed band can be faced off parallel to each other and perpendicular to the axis of the piece. It is also essential that the finish machining be concentric with the base.

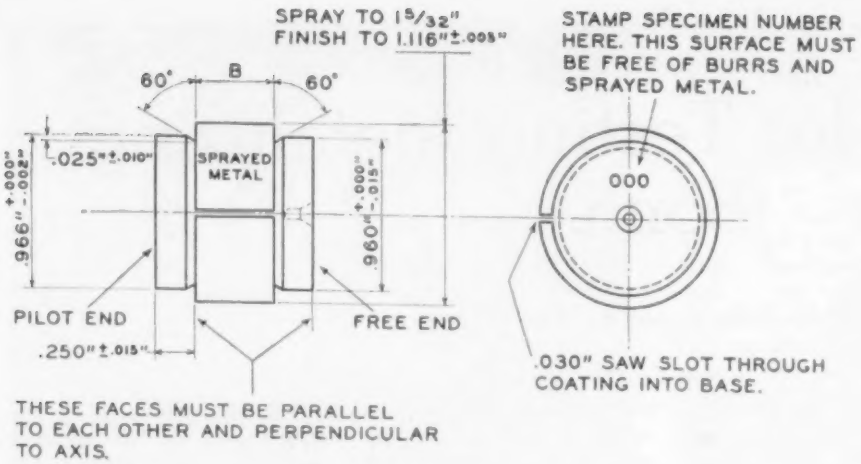
The specimen is prepared for bonding sprayed metal by the method being tested, throughout its *entire length*. Great care should be exercised to see that both preparation and all spraying conditions are under strict control and approximate the conditions which it is desired to test. This control should include wire speed, gas and



DIAMETER "A" BEFORE PREPARATION FOR SPRAYING:
FOR METCO AND OTHER MACHINING METHODS .966" ±.002"
FOR BLAST .960" ±.002"
FOR FUSE-BOND .950" ±.002"

Fig. 1—Specimen Blank Before Spraying and Machining

* Chief Engineer and Development Engineer, respectively, Metallizing Engineering Co., Inc., Long Island City, N. Y. Article also published by *Iron Age*.



DIMENSION "B" IS .500"±.002" EXCEPT WHERE CAPACITY OF TEST MACHINE WILL BE EXCEEDED. IN THIS CASE USE "B" WHICH IS .333"±.002".

Fig. 2—Completed Specimen, Sprayed, Machined and Slotted

air pressure of the gun, rotational speed of the specimen while being sprayed (taking into account surface speed), distance between the gun and the work, etc. It is also important to approximate the same temperature conditions as would be expected in the actual job of the class being tested. As most actual jobs are much larger than the test specimen and are normally kept quite cool, it has been found desirable to direct a blast of cooling air at the free end of the specimen while it is being sprayed, in order to simulate the usual temperature prevailing on an actual job.

After spraying to $1^5/_{32}$ in. in diameter over the entire prepared area, the specimen is machined to the dimensions given in Fig. 2. Care should be exercised to see that the finished machined surfaces are concentric and square with the base.

After machining, a slot is sawed completely through the sprayed coating into the base material. The purpose of this saw slot is to eliminate any bond between the coating and the base which might result from shrinkage of the coating, and thus obtain a condition such as would exist either on a flat surface, or on an interrupted cylindrical surface.

Testing Shear Strength

A shear die block is prepared in accordance with Fig. 3. Only one die block is required as there is little wear

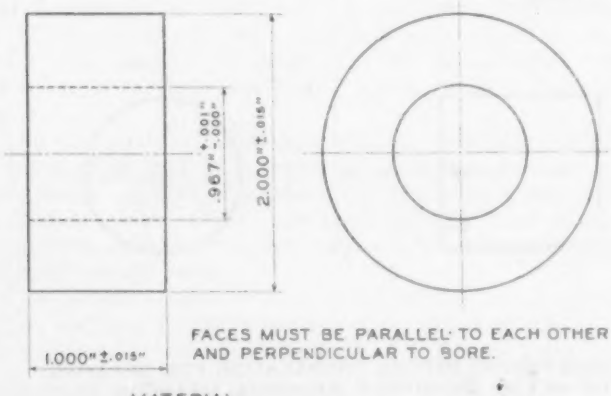

.967" +.001" -.000"
2.000"±.015"
1.000"±.015"
FACES MUST BE PARALLEL TO EACH OTHER AND PERPENDICULAR TO BORE.
MATERIAL:
TOOL STEEL - HARDEN TO 60 ROCKWELL C
GRIND FACES AND HOLE AFTER HARDENING.

Fig. 3—Die Block Used in Shear Testing of Sprayed Metal Bond

on this block, and it will test a great many specimens. The complete specimen is placed in the die block with the free end up and the pilot end in the die. The assembly is placed on the lower platen of a compression testing machine and the load applied to the numbered end of the specimen as shown in Fig. 4.

Occasionally pieces of the coating will break and fly off when the bond is broken. For this reason, a guard should be provided in front of the press.

The length of the sprayed coating B in Fig. 2 is preferably made equal to 0.500 in. In some cases, such as where grooves are used in the bonding method, this length may result in a bond strength that exceeds the capacity of the testing machine. In this case, the length B may be made 0.333 in. and the force necessary to test the specimen will be reduced by one-third. When specimens are constructed with dimension B equal to 0.500 in., the bond area is 1.5 sq. in. When B equals 0.333 in. the bond area is 1.0 sq. in. Thus, the total load necessary to shear the coating divided by this

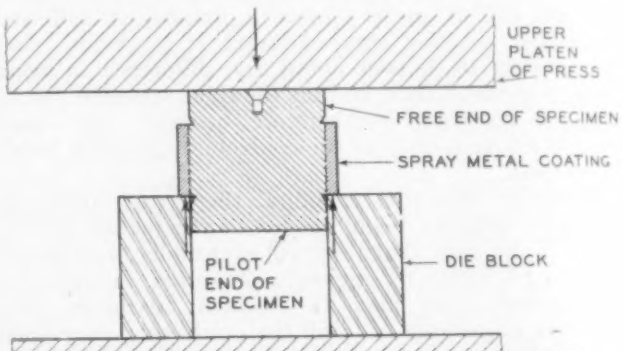


Fig. 4—Section of Shear Strength Specimen in Testing Machine

factor equals the shear strength in pounds per square inch for the bond strength of the specimen tested. Figure 5 shows a shear test specimen before and after breaking.

Tension Testing Procedure

There have been a number of fundamental problems connected with tension testing and bond strength. One problem is that results obtained in laboratory tests should be applicable to surfaces which are of different shapes, such as flat and cylindrical areas. It is also very important that the method of testing eliminates any question of the sprayed metal's internal strength. For instance, any crack or break in the metal coating caused by the test would obviously affect the apparent value of the bond strength. Another important requirement of the test specimen is that it should be adaptable to all methods of preparation, and as in the case of shear testing the preparation should be conducted under conditions as near as possible to those existing on an actual job.

The method presented here has been in use for some time and seems to have satisfactorily met all requirements. The specimen, Fig. 6, consists essentially of a

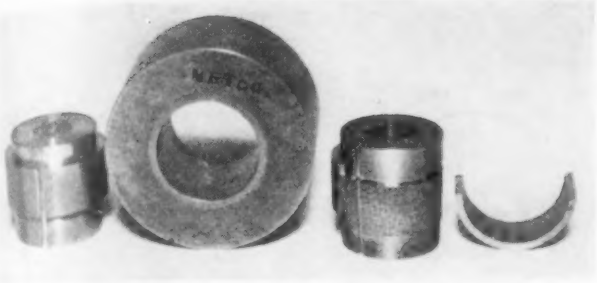


Fig. 5—Shear Test Specimens Before and After Breaking. Shown in Center Is Die Block Used in Test

shaft which has been provided with a hole clear through it and perpendicular to its axis. A stud is fitted in this hole, with one end flush with the surface of the shaft. All methods of surface preparation, including rough threading and the Metco method—in which a rotary tool is used, can be applied to this specimen under the same conditions as to a shaft in actual practice.

Preparation of the Blank

Preparation is applied all over the surface of the cylinder and, hence, to the end of the stud. After spraying and bonding, the stud is pulled out of the shaft in a testing machine. With the dimensions of the shaft, coating thickness and stud diameter properly proportioned, failure of the bond takes place on the end of the stud. There is no chance of the coating itself failing anywhere except at the destruction of the bond. The diameter of the stud has purposely been made quite small in proportion to the curvature of the sprayed surface so that any difference between results obtained with a cylindrical surface and a flat surface can be disregarded for all practical purposes.

Actual dimensions of the tension test blank are shown in Fig. 7, and specimen stud or plug in Fig. 8. Tension test blank should be made of mild steel, and specimen plug made of the base material to be tested. Plug is assembled in the blank, and fastened firmly by a set screw as shown in Fig. 6. Next, the end of the plug is machined or ground to match the cylindrical surface of the blank. The $^3/_8$-in. shoulder on the blank is provided for convenient chucking in a lathe.

With the plug firmly secured in place, the surface of the blank is then prepared for spraying by any desired method. After preparation the plug is taken out of the blank and removed of burrs caused by preparation—thus enabling the plug to slide freely in the hole. Both blank and specimen plug must be kept scrupulously clean. Even finger marks should be washed off with clean carbon tetrachloride. No oil should be used in machining.

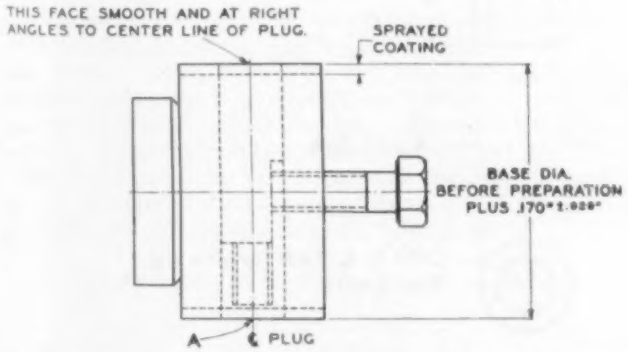

THIS FACE SMOOTH AND AT RIGHT ANGLES TO CENTER LINE OF PLUG.
SPRAYED COATING
BASE DIA. BEFORE PREPARATION PLUS .170"±.020"
A
℄ PLUG

Fig. 6—Tension Test Specimen After Spraying and Machining

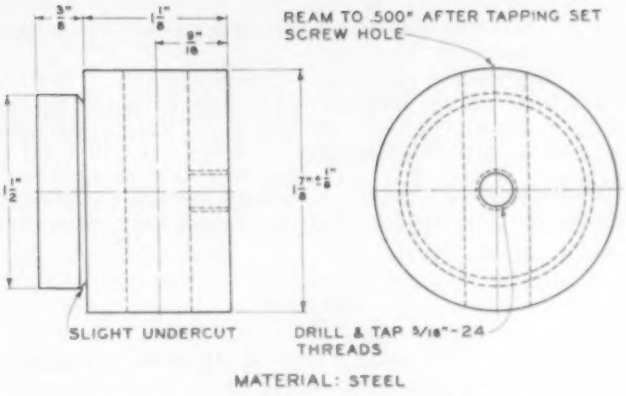


Fig. 7—Tension Test Blank Prior to Spraying

Before spraying, the plug should be replaced in the blank in *exactly the same position it was previously*. The spraying mask, illustrated in Fig. 9, is then screwed into the end of the stud at *A*, Fig. 6. This mask will prevent sprayed metal from filling up the hole and covering the threads of the plug. Specimen is then sprayed in a lathe with metal selected for the test. It is important that the spraying operation be closely controlled and that gas pressures, exact wire speed and air cap setting be recorded to permit duplication of spraying conditions.

Testing in Tension

After spraying, the mask is unscrewed from the end of plug, and specimen machined or ground to a diameter of 0.170 in. larger than the diameter before spraying. After machining, any sprayed metal particles around hole *A*, Fig. 6, should be removed.

The specimen is then assembled in the test rig as shown in Fig. 10. Figures 11 and 12 show two parts of the test rig. After screwing the pull bar (Fig. 12) onto the specimen plug, set screw shown in Fig. 6 should be removed. This screw should not be removed earlier as there is danger of damaging the bond when assembling into the rig. Rig is then mounted in a tension testing machine having a capacity of at least 5000 lb. Figure 13 shows a tension plug after pulling.

As the prepared area of the specimen plug is 0.196 sq. in., breaking load as indicated on the testing machine multiplied by 5.1 will give tensile strength of the bond in pounds per square inch.

While making the test, particular care should be taken to see that:

1. Specimen plug is machined to a good fit in the blank and will slide in the hole without any friction or scraping.
2. Set screw holds plug tight without burring edges

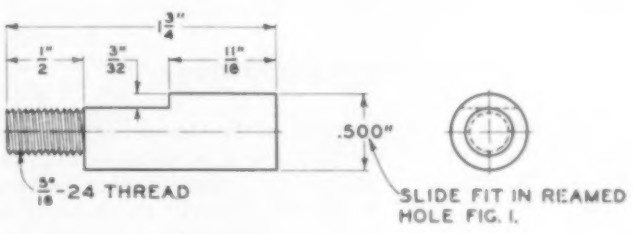


Fig. 8—Tension Test Specimen Plug. This Is Inserted in the Blank, Fig. 7, Before Spraying

of the flat section, and particularly that set screw is removed before plug is pulled in tension machine.

3. Specimen is pulled in a straight line.
4. Plug is not twisted or pulled in handling and machining sprayed specimen, especially when set screw is removed.

Wide tolerances are given on the diameter of the blank. Blanks may be machined to the upper limit when first

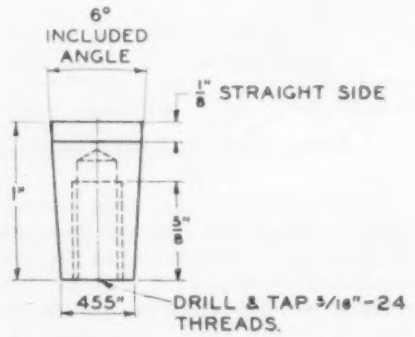


Fig. 9—Mask for Protecting Threaded End of Tension Specimen Plug During Spraying

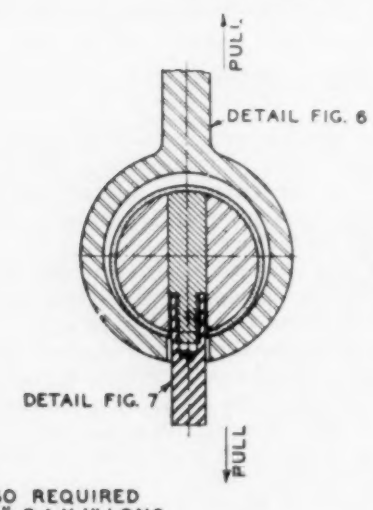


Fig. 10—Tension Test Specimen Assembled in Test Rig Ready to Be Pulled

used, and then cleaned up and re-used until the lower limit of diameter is reached. This will permit use of the same blank for a number of tests.

While the tension test specimen described requires considerable machine work, the consistent results obtained with it have justified the design. The ease with which standard methods of surface preparation can be applied is also much in its favor.

Analysis of Bond Failures

The theory of the structure of the bond between the spray metal coat and the base metal is fairly well understood. In ordinary metallizing, done under normal conditions, the bond is almost entirely mechanical in nature. The spray metal particles interlock with the mechanical projections and indentations in the base surface, depending upon the method used for surface preparation. While some slight amount of fusion between particles of spray metal and particles of base metal may take place at isolated spots, the general

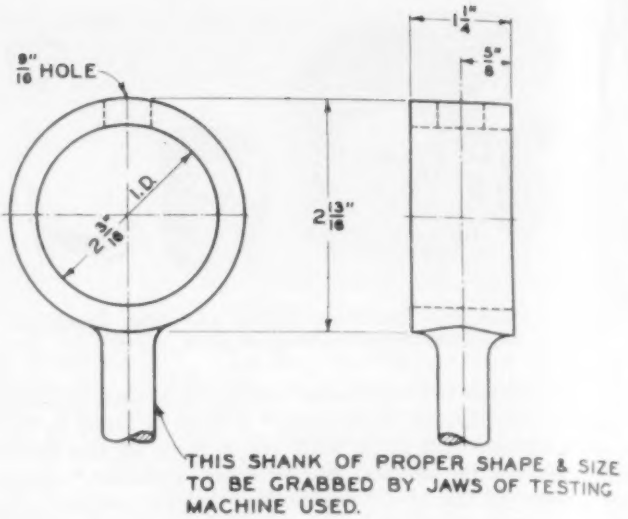


Fig. 11—Specimen Anchor Ring Used in Tension Test Rig

effect of such welding or fusion is practically insignificant.

There are, however, special uses of metallizing where the bond is not mechanical. METCOLIZED coatings, for instance, become bonded to the base metal by actual alloying. They are applied primarily to protect steel from heat corrosion and the alloying takes place either during a special heat treatment or when subjected to the normal heat applied in the use of the article.

The theory of bond failure is not as well established as the nature of the bond itself. In general, it can be said that bond failure is caused by any stress, either internal with respect to the sprayed metal coatings, or external to it, that pulls the coating from the base by distorting the interlocking projections and particles. It appears that in most bond failures the major part of this stress originates in the sprayed metal itself, due to shrinkage of the layers of sprayed metal as they are applied. If spray metal is applied on a flat surface, each layer tends

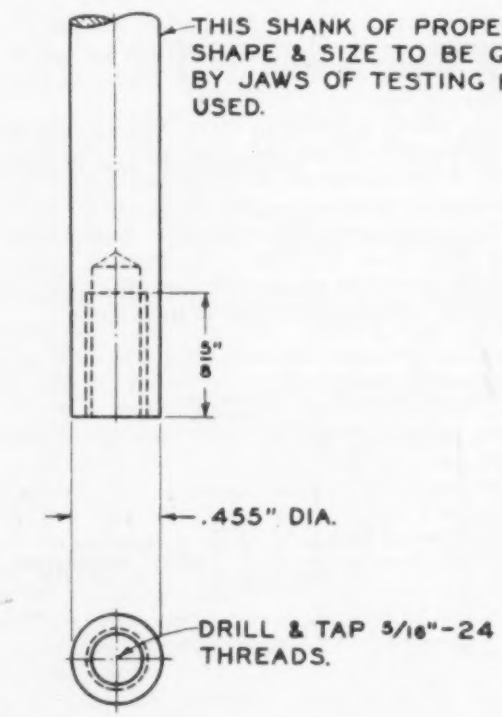


Fig. 12—Specimen Plug Pull Bar Used in Tension Test Rig

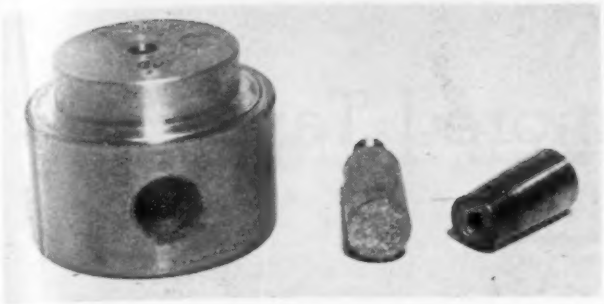


Fig 13—Tension Test Blank Specimen and Hardened Mask Used in Spraying

to shrink as it is applied, causing two effects: First, the coating tends to slide over the base and produce a shearing force at the bond; second, as successive layers are applied, each in turn tends to shrink. These shrinkage forces, acting on each other, cause the coating to tend to curl upward, and thus produce a lifting force or tensile stress at the bond. Of these two, the shearing force seems to be the more important. One theory is that the shearing action first distorts the interlocking particles, tending to weaken the bond so that the bond is at least partially destroyed by this shear, permitting the coating to lift relatively easily with a light tensile stress.

Effect of Internal Stresses

This general conclusion is partially confirmed by observing that spray metal bonds very firmly to a very small area and less firmly to a large area. For instance, the method of determining bond strength in tension, described earlier, gives a figure of approximately 3000 p.s.i. for the bond strength between sprayed METCOLOY* No. 1 and a very heavily grit blasted mild steel base. This strength was measured purposely on a small area of only 0.196 sq. in. This is a high strength, and yet if the same spray were applied to a large plate, the coating would be expected to lift of its own accord at the edge of the plate, if a heavy enough coating were applied. Thus, while the bond strength figures obtained by the methods described are a measure of the external force required to break the bond, it is quite possible when spraying heavy coatings to develop these stresses internally and break the bond without applying any external forces. This is apparent when it is considered that the shrinkage stresses increase as the coating thickness increases, while the unit bond strength remains the same.

Therefore, the important point to consider is that most bond failures are caused by internal stresses in the spray metal. There are very few applications where any appreciable load is applied externally to a spray metal coating to cause it to come loose from the base. Bond strength test values, therefore, should be considered in terms of the likelihood of the coatings coming loose by themselves rather than in terms of the relatively light external loads that can be applied.

* Trade marks registered U. S. Pat. Off.

Interpretation of Test Data

The measurement of shear strength is most important as most of the internal stress is in shear. However, shear strength alone would not be sufficient. Supposing that the base metal were grooved with deep square-sided grooves and then sprayed. The shear strength crosswise of the grooves would obviously be high and yet a coating having low tensile strength could easily be lifted off. Therefore, at least a minimum of tensile strength is required. This point must be watched in interpreting results, particularly when using grooving methods of preparation. Where such methods have adequate tensile strength, however, they do give high shear values, and for this reason give very satisfactory bonds.

A relatively high bond strength in tension with a relatively low shear strength is not good for most applications, as tensile strength will be largely destroyed by the shear action of the metal. Therefore, the two tests, tension and shear, must be considered together to give a true picture of bond strength on an actual application. The relative values required from these two tests must be decided and interpreted broadly in accordance with the type of application being considered. For instance, a shaft which has no keyways and no force applied to the coating tending to rotate it can be prepared and sprayed satisfactorily with a method which gives relatively low shear strength and tensile strength of the bond. However, it has been found that cracking of coatings on shafts usually result from lack of sufficient bond strength in shear, which permits the metal to slip slightly around the shaft and concentrate all of the shrinkage stress at one point. Thus, where heavy coatings are applied the bond should have a fairly high shear strength to avoid cracking. Where flat surfaces or shafts with keyways, etc., are sprayed, methods of preparation having as high a shear strength as possible should be used at least at the edges of the flat surface or keyways.

There are so many good methods of producing adequate bond available today, there is really no excuse for not playing safe in obtaining an adequate bond strength in both tension and shear on all jobs.

Serve as Control Criteria

The test results obtained from shear and tension bond tests have two very important uses. One is for comparing values between methods known from experience to be satisfactory and new methods or variations of methods which it is desired to use. The test results have relatively little value in an abstract sense, since the internal forces of the sprayed metal which cause the failure are not known. The other important use is for control of the surface preparation method in the shop by checking on operator technique and on equipment and supplies used. The test for bond, for instance, is the only adequate means of testing the effectiveness of blasting grit.

In conclusion, it should be pointed out that good bond strengths are easy to obtain and are desirable, if not always required, for all heavy coatings on machine element work. Therefore, the main use of bond tests is to help in obtaining and maintaining good bond strengths by the proper selection and control of bonding methods. Future articles will be published giving values of bond strengths for different metals and different methods of surface preparation.

Welding of Armored Tanks*

By William Boese†

BUILDING of substantial, quality merchandise is an All-American trait. Whether in war or in peace, American industries can be depended upon to produce the best. One example is the M-4 tank, needed quickly—and in vast numbers—to stem the flood of Axis troops threatening to overrun the entire world.

The all-welded hull of this tank was one of those developments which harkens back to peacetime days when research and study in welding were being carried on extensively by some of the country's leading manufacturers.

Here at Pullman-Standard Car Manufacturing Company we had been using welding for some time to build stronger and lighter railroad rolling stock. Because of the success we had with this program, we knew that welding could offer much in the manufacture of armament. More than two years ago we were working with the Army in conducting tests on the welding of armor plate. Pullman-Standard samples were successful in going through the fire tests at Aberdeen proving grounds.

At the beginning of the M-4 tank program, two pilot hulls were made. Careful measurements were taken before and after welding. This was done to determine the allowances that had to be provided for to produce the hull of the proper dimensions.

One of the first problems involved making the fixtures so that the hull could be readily removed. We knew that if they were built rigid we could not pull the hull off after shrinkage had taken place and, furthermore, we did not like the idea of subjecting the hull to the additional stress which would be set up in the welded joints even though the fixtures were made with removable bolts or wedges to release the hull. It was decided we must allow the hull to breathe during the welding and yet hold the proper dimensions.

Accordingly, we designed our fixtures so that one side would be rigid on a base, while the other side moved in or out. This movement was made possible by the use of air cylinders. Applying air sends one-half of the fixtures out to the expanded dimension of the hull. This is held firmly until the six long seams are welded. When shrinkage takes place, it pulls against these air cylinders, which move enough to permit free movement of the hull.

Back in the days when we were building the first streamlined train, which required much welding, and even before this time, we had learned that by allowing a welded joint to breathe during welding much trouble would be saved. We knew this to be particularly true of armor plate.

Removing the hull from these stationary fixtures is very simple. Shutting off the air retracts the movable side two inches leaving the hull free to be picked up for further operations.

Recognizing that our production of M-4 tanks could be greatly increased by the application of the principle of proper positioning, we developed giant, manipulating jigs, which are large enough to hold the hull and the stationary fixture as a unit, and position for all downhand welding. The plates are fitted before the hull goes to the manipulators and all material is either shot blasted or ground for good weldability.

Root joints are held wide enough so that proper welding can be done from both sides. We do not figure on penetration, because there is so little of this with stainless steel electrodes on armor plate. Before welding on the opposite side of a joint, it is cleaned by chipping or grinding, then inspected. This is to make sure that we again have a clean joint.

Another advantage of these power-driven manipulators is that we can use large electrodes and increase production. By having these manipulators on trucks they can be moved from one position to another without removing the hull. We have 24 of these positions.

Welders remain at the same positions along the line day after day. Some of these welders have been working on the same joints for more than a year and they become very adept. This method also has the advantage of permitting an immediate tracing of any indications of bad welding.

Each of these 24 positions requires a certain amount of man power to complete a certain number of hulls per day. Increasing or decreasing production is only a matter of adding or subtracting man power. Schedules have been worked out so that the welding at each of the 24 positions is completed simultaneously and the entire welding line is moved at one time.

Both a.-c. and d.-c. equipment is used. All subassemblies are inspected before they are applied to the hull. All hand-welded joints have an included angle of 45° or more with a $^3/_{16}$-in. minimum root gap. All material is checked for size and bevels before it is applied to the hull. Copper back-up bars are used while depositing root passes.

Electrodes which deposit a concave bead are not used in root passes. Neither do we use an electrode which deposits a full crown weld with a slight necking down at the fusion line. Both of these will cause no end of grief. Proper bead formation in the root passes will cause very little trouble in any joint. In my opinion the bead formation which has a slight crown or one perfectly flat is far superior to the other two types. Parallel joints have from the beginning of the program been frowned upon and soon eliminated wherever possible. We use the overlapping or stringer bead method on all manual welding. Annealing beads are likewise used wherever possible.

Good practices for sound welding on armor are as follows: clean material, proper root opening, proper heat for each size of rod, proper speed of travel and clean joints.

* Presented at the Annual Meeting, A.W.S., Chicago, Ill., Oct. 18 to 21, 1943.

† Welding Superintendent at Pullman-Standard Car Manufacturing Company Plant at Hammond, Ind.

Organization and Reclamation of Tools and Gages

By Joseph V. Kielb*

PURCHASE order No. 31,000—12 Dovetail Form Tools as per attached print. Yes! Thousands of similar purchase orders litter the tool vendor's plants. Probably one of your own orders is among this lot, earmarked "rush, please." Yet we will have to be content with a delivery date of from six to twenty weeks. Replacement tools can be ordered, but the tool engineers must avail themselves of some subterfuge in order to win the war against rapidly depleting tool stores. Despite many of the articles published on tool and gage salvage, production engineers blithly ignore reclamation possibilities and continue to drain the tool vendor's plants. Why ignore an "Ace in the hole"—

Tool Reclamation

Experienced operators are scarce, but the well-rounded toolmen are almost impossible to hire; thus, the tool manufacturers are sorely pressed from both sides, meanwhile these orders pile up at the tool vendors. The result is additional delay to all purchasers causing a greater slowdown in their production. Why not give more thought to reclaiming the discarded tool rather than grousing a tool we can't get?

The extreme difficulties in securing new tools and gages has, fortunately, resulted in a deeper and more thorough study of salvage possibilities, by hundreds of companies. The technical journals have displayed their wares, but still too few of us have tested salvage programs of our own. "That tool salvage article sounds pretty good" we admit, then scowl at the calendar. "Only five weeks more before they ship those dovetail form tools."

The development of a tool reclamation program necessitates a few fundamentals, but in a pinch we can overlap and still make both ends meet. In a program of this type, the tool manager must be aided by the metallurgist, tool designer, production engineer, welding engineer, factory managers and, last but not least, the set-up operator. A separate organization is generally set up to control this program in large companies while in small companies this program could come under the Production Engineering Department or the Salvaging Department. The following paragraphs explain the functions of these departmental heads in order to make a success of such a program.

Organizational Cooperation

Too often lack of complete cooperation makes this program almost negligible while it should be serving at its maximum capacity during this emergency period. Anyone connected with this program has to give his best efforts, otherwise, lack of understanding results in the lack of cooperation. Generally a short meeting with all persons concerned will result in a complete understanding of the particular item under discussion. At that time, all facts are exchanged regarding the procedure of salvaging different tools in the quickest and best manner possible. In a meeting of this type, the following types are generally discussed: purpose, material, tool design, advantages and disadvantages of the tool, type of machine, machine operation, cutting fluids, methods of handling the tool, etc.

The metallurgist generally suggests to this group the type of tool steel that is to be used, its hardness, its critical temperature before and after salvaging any tool, the type of material to be cut, heat treatment, machinability, etc. In return, he must secure from the tool engineer: feeds and speeds, type of tool and form, type of machine and its general characteristics, size of cuts, etc. Many of the details of these items can be secured from the general foreman of the set-up man who plays an important part in making a program of this type successful. This individual's suggestions should be given much consideration, and the tool engineer should understand and study these suggestions. New ideas coming from the tool engineer should be handled so that the tool set-up man feels that his suggestions have been applied. When this is done, complete cooperation in the whole organization is obtained.

Lack of cooperation can develop into something like this: a few years ago, there were several critical tools salvaged, but because of improper grinding, some of these tools were cut undersize in diameter while others were cut undersize in thickness. This was not discovered until after these tools had been set up in the machine for operation; thus, after all the work that had been put into salvaging these tools, they had to be scrapped, due to lack of cooperation on the part of certain individuals who thought these tools could not and should not be salvaged. Another incident where a lack of understanding developed was in the case of carbide tool bits. The class of carbides of one company differed from those of another. The hardness and contents of the carbides will determine whether they should be applied to ferrous or nonferrous materials. Lack of knowledge of the types of carbides, carbide grinding and tool design applications resulted in short life of these tools, which, generally, caused a great deal of confusion between the carbide room and manufacturing. A thorough study was made of the handling of carbides which resulted in the classification of carbides, centralizing grinding, proper grinding equipment, training of grinding operators and training of set-up men in the handling of carbide tools. Thus, the misunderstanding that existed was cleared up. These incidents are parallel to others occurring in many companies. As soon as we

* Staff Engineer for the Works Manager, Easy Washing Machine Corp., Syracuse, N.Y.

realize that this program to salvage critical materials and direct labor is a vital one, we will be serving our country as well as our company.

The welding engineer comes to the aid of this organization after the tool has been broken or worn down. At this time a man should be brought in, if the organization does not have a man of this caliber, to give his opinion on the different tools or gages that can be salvaged by welding. It has been found in many organizations where the tool engineer, tool draftsman and other individuals familiar with tools have a little knowledge of welding; they try to determine how this tool can be salvaged without consulting a man who is a specialist in that line and, as a result, they generally state that such a tool cannot be salvaged. After a thorough study is made of a particular tool, it is generally discovered to be salvageable; but if the other members of an organization do not cooperate in this program, that salvaged tool will still be useless, due to the failure of applying the proper procedure after salvaging.

Type of Organization

Companies who start without setting up a separate organization to control a program of this type will usually encounter failure in trying to secure the proper cooperation by all departmental heads. This type of program should have a separate organization which functions with every department which is handling tools. At the National convention of the American Tool Engineers in Milwaukee, recently, a moving picture film was shown of International Harvester's Corp. tool salvage program. It was an excellent movie and many persons seeing it took advantage of this program when trying to install a similar one at their own plant. However, some thought the film just a movie and failed to give deeper consideration to this type of program. Well, the time will come, or has come, when they will be short of essential tools and, therefore, realize there was much to learn from that film.

From Fig. 1, it can be seen that the whole program is centralized around the tool manager who controls tools and gages, from purchasing until final disposal of these tools. It is his job to control grinding by centralizing units throughout the plant, handling broken or worn-out tools and gages; estimating life on tools and gages for such operation, and keeping tool performance records. This information that the tool manager possesses will aid the tool engineer on new jobs, but the tool manager should have a voice in determining the tools necessary for a new contract, after making a complete study of any new job. This study should cover types of material to be cut, type of tool, feeds and speeds, set up by the tool engineer, cutting fluid and its application, and the size of cuts in order to determine if the tool is going to take these cuts. This program when applied to a new contract as previously mentioned requires the cooperation of the metallurgist as well as the tool engineer and designer. The tool manager is essential in this setup because he can reduce down time on machines which occurs in all plants. Thus, he can aid in a more uniform production control and also create more harmony and better cooperation between manufacturing and production engineer. Certain essential facts are necessary in the managing of these tools and gages in order to make this program a success. They are as follows:

I. No requisitions for new tools is to be made until a check is made on tools on hand that could be salvaged.

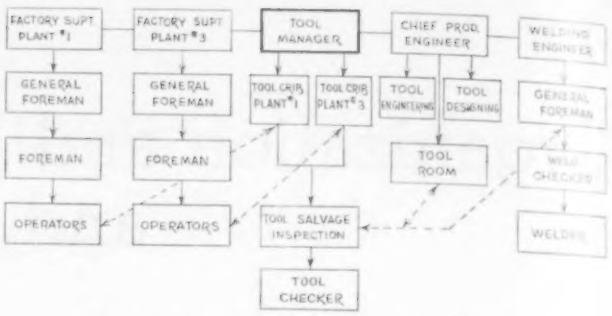


Fig. 1—Tool and Gage Salvage Organization

II. Study of causes of broken tools.
   - *A.* Tool and welding checker should determine whether a tool is to be salvaged or scrapped and the cause in either case.
   - *B.* This information should be relayed to the tool engineer and foreman of the department.

III. Flow charts on new and salvaged tools.
   - *A.* Charging of particular tools against the department and operation.
   - *B.* Follow up of salvaged tools in order to have records of the life of the tool.
     1. Installation of an index system.
     2. Establishing standardized tools—complete history of the tool from the day it enters the plant until it is scrapped.

IV. Checking of salvaged tool.
   - *A.* Salvaged tools should be used before new tools are released.
   - *B.* Daily records should be kept in checking the life of salvaged tools which have been used.
   - *C.* Follow-up of all tools by an assistant to tool manager.

The tool manager is the coordinator between manufacturing and production engineering. Likewise efficiency of production control depends directly on the efficiency of this tool salvaging organization as a working unit.

A great deal of follow-up is essential in this program in order to find out whether a tool can be salvaged and whether it has proved its value. In many instances, tools can be salvaged where the cost might be slightly higher than the original cost of the tool, but the saving on down time on machines makes this tool valuable from a salvage angle. Generally on most tools that are salvaged, the cost is far below that of the original cost of the new tool. The follow-up study usually gives one of these answers—but too often tool salvage history dies because of lack of such information in the tool salvage organization. Another duty to be worked out by the follow-up man is to chase tools that have died before reaching the machine, due to the lack of proper machine repairs such as fit-up, poor grinding or discarding the tool before careful examination.

From the diagram in Fig. 1, let us follow a particular tool. In Plant No. 1, a milling cutter is broken down into pieces. The operator handling the milling machines informs the foreman of that department. The foreman in turn takes this tool back to the tool crib where a tool salvage ticket, as illustrated in Fig. 2, is placed on this tool. In the tool crib, the tool checker determines whether this tool can be salvaged or whether it will be scrapped. He also determines the causes of the breakdown of this tool and informs the foreman, who

TOOL SALVAGE TICKET				NO.		
DATED / /194	TOOL NAME		TOOL NO.	TOOL DEPT.		
BREAKAGE CAUSE				WELDING CHECKER		
TOOL CHK'R. DATE				DATE		
DISPOSITION --	TOOL SALVAGE		RETURN TO VENDOR	SCRAP	REPAIR	
	SALVAGE	OBSOLETE				
ORDER ISSUED --	REWORK	SCRAP	NEW SALV. TOOL NO.	POSTED TOOL CRIB CONT.	COST DEPT.	

Fig. 2

in turn informs the operator why this tool was broken. Paper work of this tool informs the general foreman as well as the plant manager of Plant No. 1. Also, the tool manager informs the chief production engineer and the welding engineer about a tool that is to be salvaged. This broken tool, after inspection, if it is going to be salvaged, will go to the machine shop if any parts have to be machined, or it might go directly to the welding department if the fit-up is such that it does not require any machining.

In the welding department, the tool is checked and placed in the proper fixture to be welded. After this is done, the tool is returned to the tool manager, who in turn checks setup and if any machining is necessary it is returned to the machine shop. This tool is then recorded and placed in the tool crib under the department or tool number in which it is going to be used. This tool is then issued when the next call for a tool of that type is written up by the operator. In turn that tool is then followed up by the follow-up man under the tool manager, who keeps daily contact on that tool until it is finally scrapped. All of this information is recorded on the flow charts of that particular tool. Such a setup exists in the handling of gages which are generally worn down rather than being broken. Where gages wear down rapidly—particularly plug gages—carbide tips are inserted on the wear area in order to prevent this condition developing again in the gage.

A particular incident is where the production is high and 100% inspection is necessary. An ordinary plug gage became undersize as rapidly as 0.0001 in. within an hour. By inserting carbides on the plug gage, it was used for a period of seven weeks. It was checked at different intervals and it was found that there had been no wear down on this gage during that period. This proved to be very profitable as well as a very efficient means of maintaining production control.

Easy Tool and Gage Salvaging

About a year ago, a program for salvaging critical tools was started at "Easy." In starting this program, it was necessary to explain to everyone concerned with handling tools, the purpose of such a program. It was noticed that many were of the opinion that the majority of these tools could not be salvaged, but by showing them results of similar programs conducted by other companies and by the actual illustration of repairing a few samples, they were convinced that such a program was essential.

The start of this program was the replacing of carbide inserts on Sil-Man shanks. Many of the new tool bits broke off at the start of an operation due to poor brazing, and therefore, had to be rebrazed, or in some instances new carbides had to be placed on these shanks and brazed. Several hundred Sil-Man shanks had accumulated over a period of time and the question arose, whether it was cheaper to buy standard tool bits or just buy the carbide inserts and placing them on the accumulated shanks was much cheaper. Brazing the carbides to these shanks made these tool bits standard, which instituted the first stop toward the purchase of standard tool bits. For example: a $^5/_8$-in. tool bit average cost is $1.90 as a standard tool, but buying only carbide inserts, which cost approximately $0.58, plus $0.12 for brazing and $0.20 for tool room milling of the surface of the tool bit before brazing, resulted in a total cost of $0.90 for replacing that tool bit in the standard catagory. A saving of $1.00 per tool resulted in this installation, and over a period of a month, several hundred dollars were saved on this one item alone.

One of the first difficult tools on which experimentation was started is illustrated in Fig. 3, which is known as the common dovetail tool. This illustration shows the salvaging of a dovetail tool by the use of a mild steel block brazed to the other end of a high-speed dovetail tool. Large quantities of tools of this type are used by the company. Delivery dates on such tools were especially long and, in order to prevent down time on these machines, a procedure was worked out whereby we could salvage this tool. A definite procedure was set up and was applied to any other similar tools. The paragraphs to follow will explain the methods used in order to develop a definite procedure for the handling of this tool and others.

At the start, gas welding was employed for brazing of these tools. The welding wire was a low-temperature brazing alloy wire with a melting range of between 1150 and 1250° F. The first few tools proved quite successful although a few failures resulted, due to the fact that the bonding metals between these two materials was not perfect. Brazing strip material was then used, which resulted in giving better bonding of the joint. Another method, of using constantan with strips of Easy Flow No. 3 between the tool steel and the mild steel block, was later applied on certain form tools. This proved very successful, and was set up as one of the procedures in handling these tools. Later, induction welding of these tools was set up instead of the gas-welding method, which gave us a more uniform heat in the proper fusion areas and also prevented any cracking of the tool steel.

It was found that the thermal coefficient of expansion of the three metals—the mild steel, the tool steel and the brazing wire—was different, and on some occasions setting up of internal stresses in the bonded area developed, resulting in the breaking of this welded tool in that area.

Two essential items of saving are involved in this

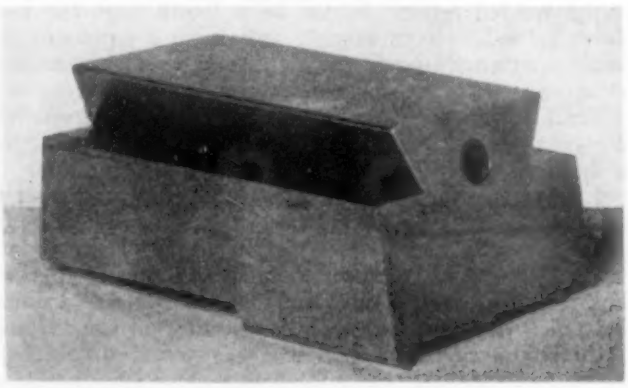


Fig. 3—A Common Dovetail Form Tool Reclaimed by Brazing and Machining

Fig. 4—Joint Preparation before Arc Welding of a Reclaimed Cutter

tool as well as any other tools that will be described in later paragraphs. First and most important was the elimination of down time on machines. This factor is very important for if an insufficient amount of tools are available, it causes not only down time on machines but also idle time for direct labor. The second item is cost saving. The approximate cost of this tool, new, ranges from $40.00 to $50.00 and about half of this tool is discarded due to the fact that it cannot be held in the form tool holder. The value of this discarded tool is approximately $20.00 or $25.00, which is reclaimed through this salvaging program. The cost saving on other tools ranged from $1.00 to $145.00, but in most cases the down time of the machines was more important.

Important Factors in Salvaging

There are several items of importance that should be brought forth at this time in order to simplify the salvaging procedure of this tool or any tools and they are as follows:

I. Fit-up of the welded joint. Where a break of the tool is clean and the piece can be fitted perfectly, leaving a clearance of from 0.001 to 0.003 in., no machining of fit-up is necessary. At all times, when using a low-temperature brazing material, the joint should have a fit-up as indicated, in order to receive the maximum strength which generally occurs at a fit-up of 0.001 in.

A. Proper fixtures for alignment of tools is essential. Care should be taken not to apply too much pressure of the welded joint. It has been found that the two pieces forced in compression will have a tendency to break apart due to the fact that internal stresses are set up caused by rate of cooling in the welding area.

II. Cleanliness of the tools to be welded. Very often this point is neglected and generally results in failure of the welded joint.

A. Preparation of the joint by cleaning with carbon tetrachloride or any other solution that will eliminate grease and dirt, also oil from the surface of the steel.

B. Use of sufficient flux before fitting pieces in the welded areas. This flux may be placed around the tool to prevent oxidation developing on the surface of this tool caused by the heat of the torch. It will also aid in cleaning the tool much more rapidly after welding.

C. Check welding surfaces to make sure they do not have smooth machined surface. It has been found that mirror-like surfaces give poor fusion in the welded area.

III. Method of welding—gas, induction and arc.

A. In gas welding of these tools, care should be taken in flame control in order to prevent the overheating of the tool steel in the welded area, which might cause reduction in hardness of the tool steel, and in addition, hair-line cracks may develop in the tool steel. Too rapid heating will tend to cause poor welding of the tool, which generally results in unwelded areas in center of the tool. The size of tip of the torch and the amount of pressure on the torch are also important as is maintaining the proper flame, which should be neutral or slightly carbonizing—avoid an oxidizing flame.

B. Tool salvage by induction. This method has eliminated the welding heat control problems that exist in the handling of those tools. The conception of welding heat temperatures in individual welders varied so much that on several occasions the hardness of the tool steel was reduced, due to slight annealing of the fusion area of the tool steel. In induction welding, the timing cycle is controlled automatically and thus controls the heating temperatures. Proper designing of coils to fit the tool to be salvaged is important. Although this coil preparation involves a little more study and work, if the production of your tool salvage is high enough, it will repay the cost of this preparation. Various types of coils have been designed for welding of carbide tips to steel shanks, which we at "Easy" have been doing for some time. Illustrations in many of the technical papers on carbide welding by induction have applied to a particular tool, but a slight adaptation had to be devised, this might prove to be an advantage in all tools. The design of the coil generally differs a little in all companies and as such is an individual problem.

Practically any kind of machine tool can be handled through induction brazing—including cutting tools, drills, plug gages, broaches, end mills, form cutting tools, drill shank, extensions, milling cutters, carbide inserts, etc. It is important to have a large enough induction machine in order to handle most any type of tool. With smaller machines, it has been found that the time cycle increased proportionately, thus the heat is transmitted in the tool steel area, which reduces the hardness of the tool steel. The general hardness maintained for these tools is around 63–65,R.c. A great deal of thought and study should be given to this method as it has a wide scope in the brazing of tools as well as its application for production parts.

C. Arc welding of tool steel. A great deal of care has to be taken in order to arc weld tool steel to mild steel successfully. Proper heat controls, types of electrodes, annealing, preheating and quenching are involved under this method of handling. Figure 4 illustrates the arc welding of high-speed steel cutters to a high-speed shank which has been annealed. After trying many types of electrodes, the most successful proved to be Ampco electrode, which is an aluminum bronze electrode. Even with this electrode, care had to be taken in the welding technique as there was a tendency

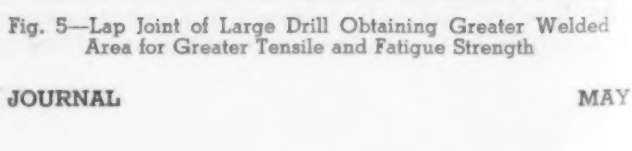


Fig. 5—Lap Joint of Large Drill Obtaining Greater Welded Area for Greater Tensile and Fatigue Strength

Fig. 6—Minimum Machining Preparation of this Large Drill by a Square Butt Joint

of cracking in either wall if too much whipping of the electrode was done. Other types of tools have been salvaged through arc welding with special high-speed tool steel electrodes, but special preparation before and during the welding of the tool steel had to be taken.

IV. Proper handling of cooling. Too rapid cooling or chilling will have a tendency to cause a break in the tool steel or the welded area. Keeping the tool out of drafts or protecting it by some type of cover such as asbestos, lime, etc., results in slower cooling and will give an excellent welded joint.

V. Machining of these tools is generally at a minimum and on some occasions where brazing materials other than low temperatures are used, great care should be taken in machining the surfaces of the welded area both before and after welding. It is generally advisable to leave a reinforcement weld as a protective means in the fusion zone where the joint has been chamfered, but is not essential if the welded area has been properly handled.

As illustrated in Fig. 5, the salvaging of this tool required more machining than is generally necessary, but it tends to develop a stronger type of joint than the setup which is illustrated in Fig. 6. After a careful study and follow-up of these tools, it was found that the tool in Fig. 4 served our means and proved successful, resulting in minimum amount of machining. This, therefore, was set up by us as a regular procedure for that particular operation. The type of joint as illustrated in Fig. 5 was applied to small drills, where several hundred were salvaged using this type of joint. This proved to be the most economical and efficient for the particular operation involved. Figure 7 illustrates this extra long drill before and after salvaging.

With regards to gages, it was found that many plug gages wore down very rapidly. Figure 8 illustrates several plug gages with different types of carbide inserts. As mentioned previously, it was found that this method proved very successful, which eliminated rework on many hundreds of plugs and in addition, the purchase of new gages. It relieved the tool room of much grinding work and aided in increasing production inspection. Many of these gages were in operation as long as three months without any wear of the outside diameter of the gage.

In Fig. 8, Plug Gage No. 1 illustrates the application of carbides that were available in our plant for immediate service. Carbides $^{7}/_{8}$ in. square were placed on the sides of this plug gage, which had machined flat surfaces. Grinding difficulties were encountered after brazing due to these carbides being square; but if circular carbides of $1^{1}/_{16}$-in. diam. had been purchased, it would have been several weeks before we received them. The nature of this job warrants the setup as shown, which prevented any down time on production inspection. Plug Gage No. 2 illustrates another emergency, but in this case, four pieces of $^{5}/_{8}$ in. square carbide were placed on the surface of the diameter of this plug gage, and brazed. Although in this case too, excessive grinding was necessary due to the oversized carbides, the importance of salvaging this gage outweighed any other factors, as it prevented down time of production. Once these gages were in service, they aided in reducing grinding time in the tool room on ordinary plug gages. Plug Gage No. 3 was the first gage used in this program. No round carbides were available but a $^{5}/_{8}$ in. square carbide was placed on the surface of the diameter of the plug gage. After grinding this gage down to the proper size, it was in service many months without any wear.

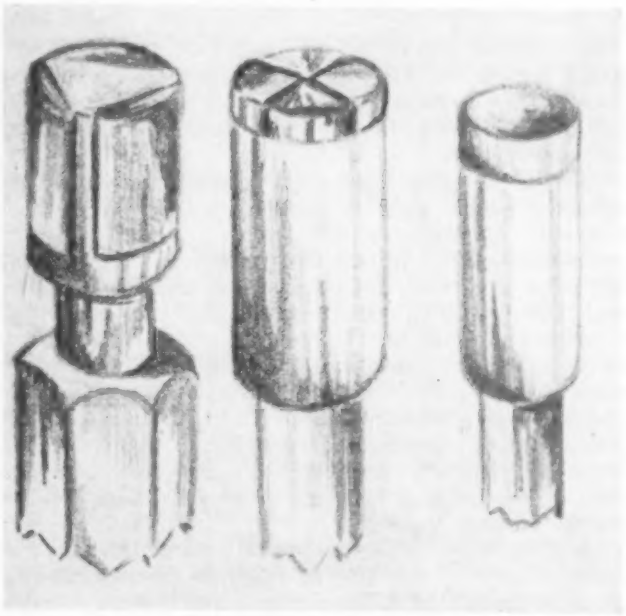


Fig. 8—These Three Types of Plug Gages Reclaimed by Different Methods Since

Much thought was given to the application of glass plug gages, but it was found that carbide inserts did an excellent job. Occasionally, on small diameter plug gages of $^{1}/_{16}$- to $^{1}/_{32}$-in. diam., difficulty was encountered in brazing and grinding. It was not the brazing of the carbide insert, but generally the placing of a temporary steel bar on the carbide, which was used for centering of the gage while grinding, that caused a little trouble. Carelessness in grinding, such as rough handling and using the wrong grinding wheels, resulted in overheating of the carbide, thus causing the carbide to crack, and it also broke the fusion zone area. It was found that a training program was necessary in order

Fig. 7—Small Drill Preparation for Machining and Brazing with Extended Shanks

to have proper handling in the grinding of carbides. This program was later set up, thus eliminating much of this trouble.

The wearing down of these gages as fast as 0.0001 per hour caused six and seven plug gages to be used per shift on that particular job. In several cases "Easy" salvaged many of these plugs by chrome plating. Both practices are used, depending on which one is best suited. In the use of circular carbide inserts it is advisable to use only those which are 0.001 or 0.002 oversize. This keeps the amount of grinding in the tool room to a minimum. The question of grinding these plug gages after brazing the carbide proved to be difficult at the start, but this difficulty was eliminated by inserting a small piece of mild steel bar stock in the center of the carbide and brazing it to the carbide, which was used as a temporary center. A great deal of care had to be taken not to apply too much heat to this little piece of steel so that it would not break the bond of the carbide tip with the plug gage. The steel extension was removed after the gage had been turned down to the required size.

In most all the tool salvage operations, women welders were employed. It has been found that they have a more sensitive touch in doing fine work such as is required in this program. Close supervision over these welders was necessary, particularly on a new job. The illustrations as shown are only a few of the many types of tools that "Easy" is reclaiming in order to assist in the war effort as well as to help themselves in overcoming this shortage of critical tools.

Good organization is necessary to keep this program at its peak, but unless the cooperation of all concerned is secured, a salvaging program cannot be accorded its full importance. Although we are far from our goal in this tool salvage program, every day more and more tools are being salvaged which eliminates the necessity of purchasing new tools in such great quantities.

Gas Cutting Stainless Clad Plate*

HERETOFORE it has been common practice to gas cut stainless clad mild steel plate to within 1/4 in. of the finished dimension and to chip away the excess metal.

Using a modified high-speed cutting nozzle recommended for cutting carbon steel plate 6 to 8 in. in thickness, and approximately 30% of the recommended oxygen pressure, the Chicago Bridge & Iron Co. has been able to produce cuts in 1 1/2-in. thick stainless clad mild steel plate, equal in speed and quality in every respect to those produced on 1 1/2-in. mild steel using conventional equipment. Mr. Lundbom of this company has cut double bevels with two torches at the same time and experience no difficulty, although the thickness of the cladding has varied from 15 to 45% of the total plate thickness. Burned edges are soft and easily chipped, whereas machined edges are work-hardened and extremely difficult to chip.

Hand burning, while somewhat more difficult than machine burning, can still be made to produce an edge equal in quality to burned edges which were received from the mill. With a little practice, a hand burner can produce acceptable cuts in stainless clad mild steel plate.

Machine Cutting

Mr. Lundbom has produced both straight and bevel cuts equal in quality and speed to those which we are accustomed to getting on ordinary steel of the same thickness. Machine cutting, using the techniques indicated, is no more difficult than cutting mild steel. If for some reason the cut is lost it can be restarted only after a smooth edge surface is prepared by chipping or preferably by melting down the edge with a mild steel electrode using straight polarity and high heat.

Technique in cutting 1 1/2-in. A.S.T.M. A201 plate with 20% A.I.S.I. Type 347 Cladding. Use a high-speed machine cutting nozzle with a cutting bore of No. 46 drill size and six preheats of No. 65 drill size. This nozzle is recommended for cutting thickness of mild steel of 6-8 in.

90° Cut

Preheat acetylene—8–10 psi.
Preheat oxygen—30 psi. (neutral flame)
Cutting oxygen—32 psi.
Torch inclined 16° backward lag
Speed—10 to 11 in. per minute

36° Bevel

Preheat acetylene—10 psi.
Preheat oxygen—30 psi. (neutral flame)
Cutting oxygen—38 psi.
16° backward lag
Speed 10 to 11 in. per minute

Hand Cutting

Hand cutting is somewhat more difficult because of the high preheat which is necessary. To start by piercing is impossible and it is necessary to melt out a starting hole, but this can be readily done using an ordinary mild steel electrode. Hand cuts are a little more irregular than obtained on mild steel, but by cutting about 1/4 in. away from the finish line, then making a second cut, trimming off this rough excess stock, a smooth finish can be obtained quite readily.

Technique: The same technique is used as above except that the acetylene pressure is 18 psi. and the oxygen pressure is 48 psi.

Torch should be slightly inclined in the direction of the cut. For 3/4 in. plate use a nozzle with a cutting bore of No. 53 drill size and six preheats of No. 81 drill size for both machine and hand cutting. Other conditions remain about the same. This nozzle is used in cutting mild steel 2 to 6 in. in thickness.

* From information supplied by the Chicago Bridge & Iron Co.

Sequence in Welding of Ships*

By O. Ovregaard†

PART I

THE structural engineer is more fortunate than the naval architect because he is in a position to determine with a fair degree of accuracy the stresses which his constructions may be subjected to. The naval architect, however, is confronted with problems where load and stresses are more in the nature of assumptions. The load conditions are determined by distribution of hull weight, cargo, hydraulic pressure, propulsive power, wave conditions and weather conditions. While the ship is in sea way, the weight components of cargo and the hull are changing position continuously with relations to each other. It is impossible to obtain an exact knowledge of the forces and the direction at any time during sea way, and even if it were possible to obtain these forces, the hull represents such a complicated construction that it would be next to impossible to follow in detail the direction of the forces and their resulting stresses through the different connections. It is true that research work carried out during recent years, for instance, the Sag and Hog test carried out by Captain C. O. Kell, U. S. Navy, on static bending of a destroyer and the work carried out by Professor Schnadel during the voyage from Europe to San Francisco of 12,000 t.d.w. cargo ship, has given much valuable information which might serve as the foundation for a more accurate calculation of stresses. On the other hand, the complicated hull construction referred to precludes exact calculations. We have to be satisfied with comparing the computations with experimental values, and use the experiences compiled by the classification societies as a criterion. The classification societies have altered during a number of years the thickness of material in hull construction on the basis of experience which has been compiled about the operation of vessels since Lloyds Register was a coffee house in London. In many cases the rivets have been used as a criterion for this trial and error process. Where, for instance, the stresses have been excessive, and rivets having loosened without being sheared off, the surveyors have reported the case and the classification societies have taken their precautions. In many cases, the rivets have unquestionably been the source of damage either by the reduction of material stresses caused by rivet holes, or by the special designs which have been required by riveted connections. Welding as a method of joining the hull components, therefore results in a greater freedom of design, and it is possible to develop structural members which will transmit the forces more directly, and reduce material stresses considerably.

The most obvious path to follow when replacing the riveted structure with welded is to make use of material testing laboratories and preferably compare the riveted connection with the welded ones, thereafter to make thorough use of strength calculations particularly in connection with details to a much greater extent than has been practiced hitherto. In this connection it should be mentioned that good welding practice starts with the designing office. If the designing engineers and draftsmen are not thoroughly familiar with welded instructions, and unable to compute welding stresses, they are unable to prescribe the correct connections and the exact calculations of same. The welders out in the yard may be as competent as it is possible to be; if the welded design is not correctly carried out, they cannot produce a first-class welded hull.

Welded Connections

It is not the object of this lecture to discuss the different forms of connections such as butt, overlap or automatic versus manual welding, but rather to discuss the most desirable method and sequence of welding in ship's hulls. Certain connections, however, will be mentioned in order to point out their characteristics and failures. To illustrate this, for instance, we will refer to a cross connection, i.e., an intersection, either a longitudinal welded on both sides of a transverse, or a transverse, for instance a floor, welded to each side of a longitudinal. The usual failure in such connections takes place in the lines through the root of the weld, the direction is 45°. The normal force perpendicular to the surface rupture is, therefore, force divided with (2 cos A). If we assume that the stress is evenly distributed over the ruptured surface, the transmitted force through both fillet welds at the cross connection is $W = 2l.k_b.a$ where l is the length of the fillet weld and k_b is the working stress of the welding material and a = throat. Tests have proved that this assumption of rupture of fillet weld is correct.

The transverse butts of the ship should always be butt welded in order to obtain a fair hull of minimum resistance. There are many shipbuilders, however, that prefer overlapped seams, as these simplify construction and reduce the stresses inherent to butt welds. Another important factor generally overlooked in the connection with overlapped joints with fillet welds, is the fact that a steel plate is slightly convex due to the cooling stresses along the edges. When using overlapped joints with fillet welds, these stresses are released without causing any warping of the plate in other directions. Inasmuch as an overlap subjected to stress will receive only slight deformation, there is no object having the overlap greater than about 2 times thickness, plus $^5/_8$ in. It is generally assumed that the yield point by shearing is $^1/_2$ of the yield point by stress, and that the ratio by ultimate sheering to ultimate stress equals 0.72. The writer, however, has measured this to 0.75.

Static Strength of Welded Hulls

By static forces, particularly on welded connections, the strength is 100% regardless of whether the material

* Copyrighted by author. Presented before San Francisco Section, A.W.S., October 1942.

† Naval Architect, Moore Dry Dock Co. (Now with Los Angeles Shipbuilding & Dry Dock Corp. Managing Agent, Todd Shipyards Corp., San Pedro, Calif.)

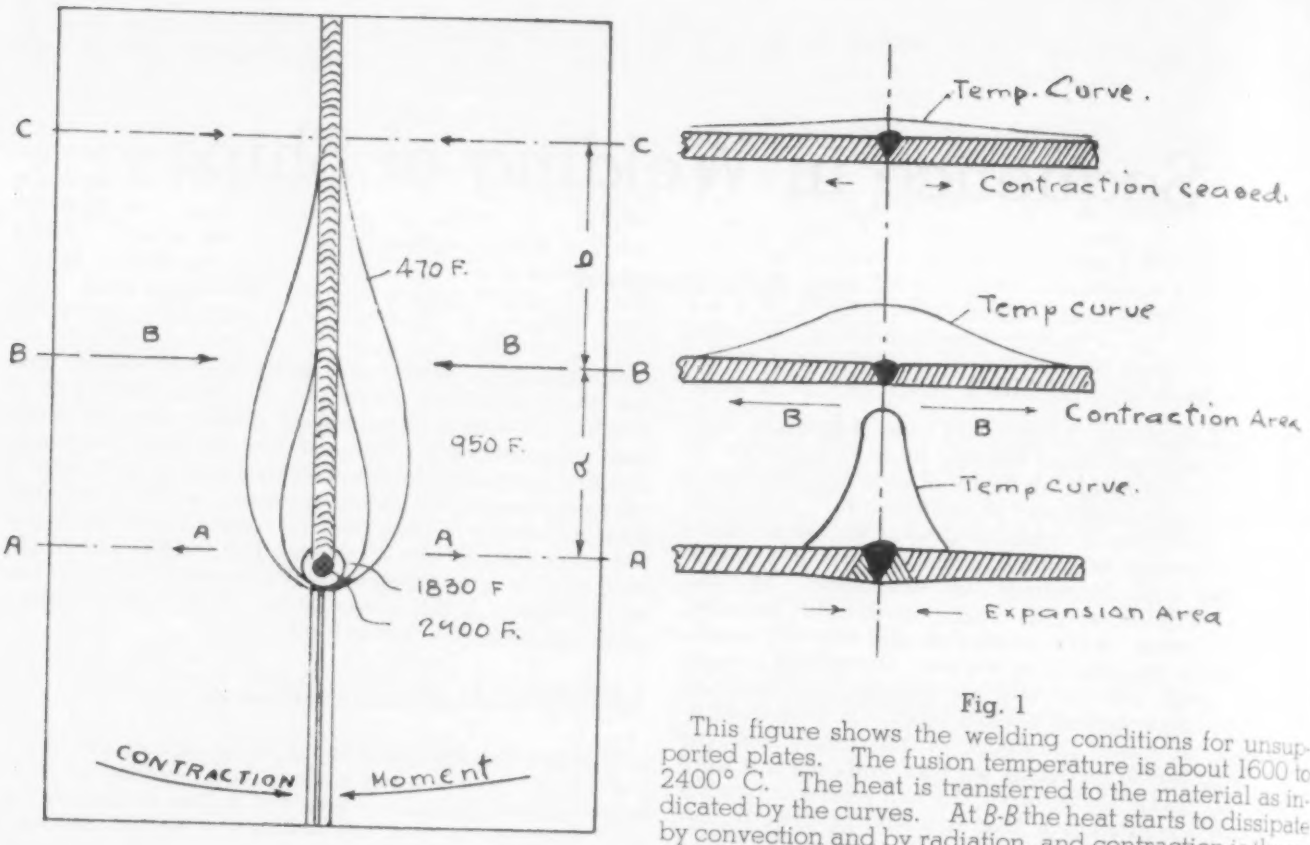
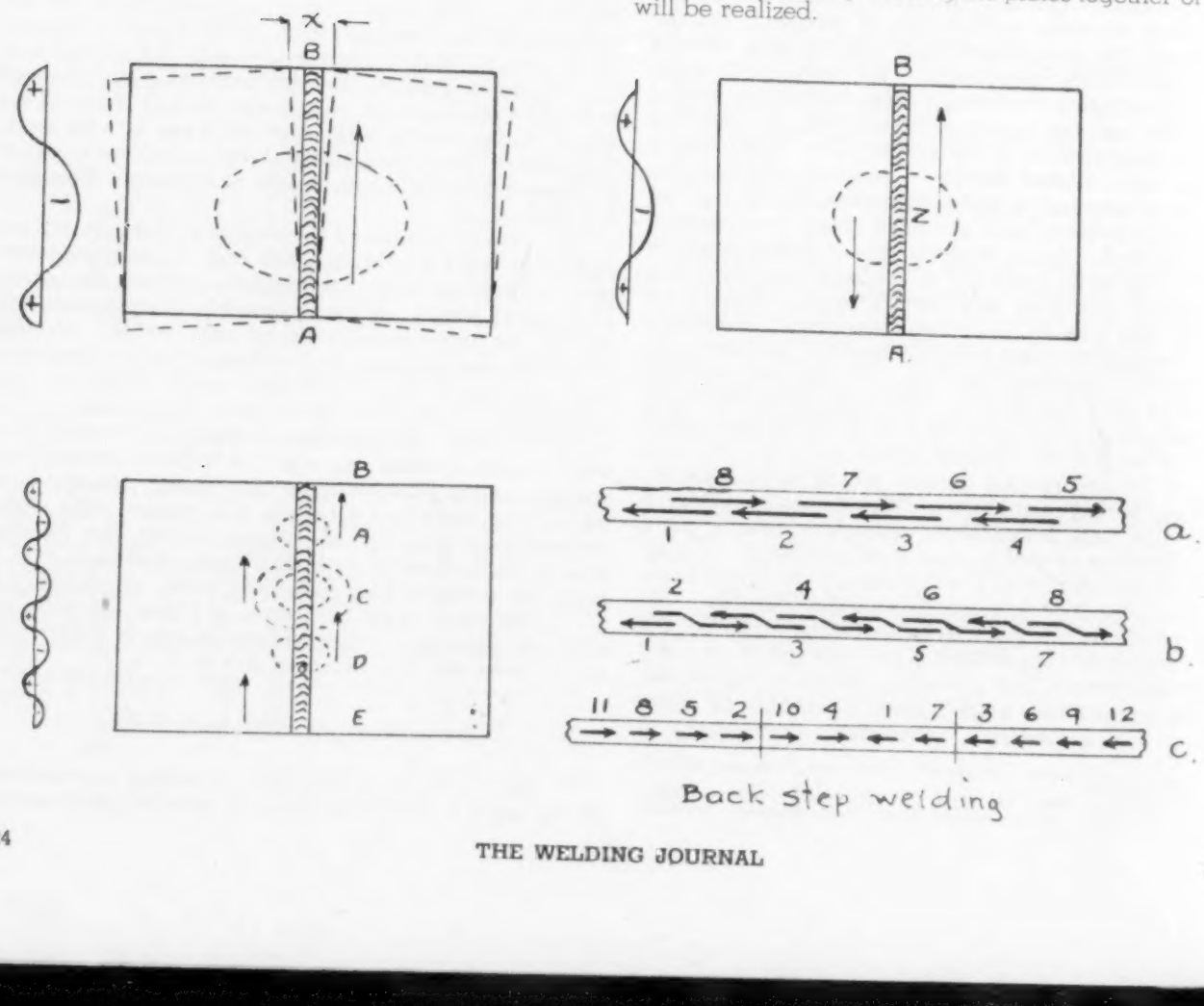


Fig. 1

This figure shows the welding conditions for unsupported plates. The fusion temperature is about 1600 to 2400° C. The heat is transferred to the material as indicated by the curves. At *B-B* the heat starts to dissipate by convection and by radiation, and contraction is therefore present. *A-C-E* the cooling and contraction, is either completed or takes place very slowly, and will, therefore, counteract the intense contraction at *B-B*. The contraction forces B will have a moment at *C-C* of *Exb*, whereas the expansion forces at *A* will have an opposite moment *A* (*a* + *b*). Practical experience indicates that with slow welding the moment about *Bx* will exceed thereby a tendency to bring the plates together or apart will be realized.



stress of the connection is below 100% or not, because the minor elongation will be absorbed by the plates adjacent to the welded connections, the elasticity of the weld joint is therefore not of major importance. Welded connections subjected to perpendicular forces will in fact resist after the yield point has been exceeded, due to the dampening effect. For riveted connections resistance to perpendicular forces are, however, much lower and only about 33% for single riveted overlap to 68% with a double riveted overlap, and a maximum of 90% with the best riveted connection. Before the yield point has been reached, however, the rivets will lose their efficiency, particularly if water tightness is required, because the rivets will loosen, and the caulking along the plate edge will open. In fact, a riveted connection will show perceptible sliding even by comparatively small stresses. As a rule we might assume this loss of friction in the overlap takes place at about 17,000 psi. When the friction between the riveted connections is exceeded, and the rivets subjected to direct shearing, the destruction of the section is going very fast, and generally takes place at about 30,000 psi., whereas the welded connections will continue to hold up until the yield point of the material has been reached. The most ideal connections will, of course, be one where the welded material, if possible, would have the same yield and elongation as the ship's steel, and this is generally the case with the modern electrodes of today. In fact, we have several examples where the fault fissures have started in the ship's steel instead of in the welded connection, this of course, being due to the fact that the yield point of the ship's steel was lower than the yield point of the welding material.

The vulnerability of a hull, or its ability to resist collisions and shocks, is really a measure of its resistance against spreading of a local fracture due to impact stresses. It has been proved on a number of occasions that welded vessels possess far greater resistance to such shock than riveted vessels. In fact, collision damage to a welded vessel is more local, whereas in a riveted vessel the damage may have far reaching effect, and will start shearing rivets at a considerable distance from the point of impact.

Fatigue

The most important question in connection with welded ship construction is resistance against fatigue stresses, which is more or less an undetermined factor. A vessel in sea way is subjected to a number of varying stresses, alternating between maximum and minimum, the frequency depending upon the waves and wind. The writer has carried out stress measurements on an all-welded vessel during heavy seas, and has found that the stresses measured as elongation on a Huggenberger tensometer were uniform for butts and adjacent material, and whether the stresses in longitudinal fillet welds were excessive. The said measurements, aside from proving that fillet welds prescribed by N. Veritas were satisfactory, also indicated the same ratio between deck and bottom stresses, as found by Dr. Schnadel, referred to in the foregoing. The importance of such tests can hardly be overemphasized, because they give results which are exact, and which are of extreme value in modern shipbuilding. It is not unusual that stresses approaching the yield point are reached during the laboring of a vessel in heavy sea waves, but the characteristics of the steel take care of such stresses by dampening in such a manner that the material reverts to its original condition. Two outstanding failures in ship construction due to fatigue stresses are mentioned in practically all recent handbooks—the failure of the decks in the S.S. *Leviathan* and S.S. *Majestic*. A very comprehensive description of these failures is also found in the proceedings of Society of Naval Architects and Marine Engineers.

Considering the low frequency of hull stresses and the comparatively long periods of rest enjoyed by vessels in calm water and in port, we might be safe in neglecting fatigue stresses except in connection with sharp corners and faulty design, which might be classified as source of fatigue stresses. In most cases sources of fatigue stresses may be entirely eliminated by welded construction. In fact, weight might be saved by confining the area of fatigue stresses to a smaller space than can be accomplished by riveting. An illustrative example on this are doubling plates in the corner of hatches and openings in deck, by welding the sizes of these doubler

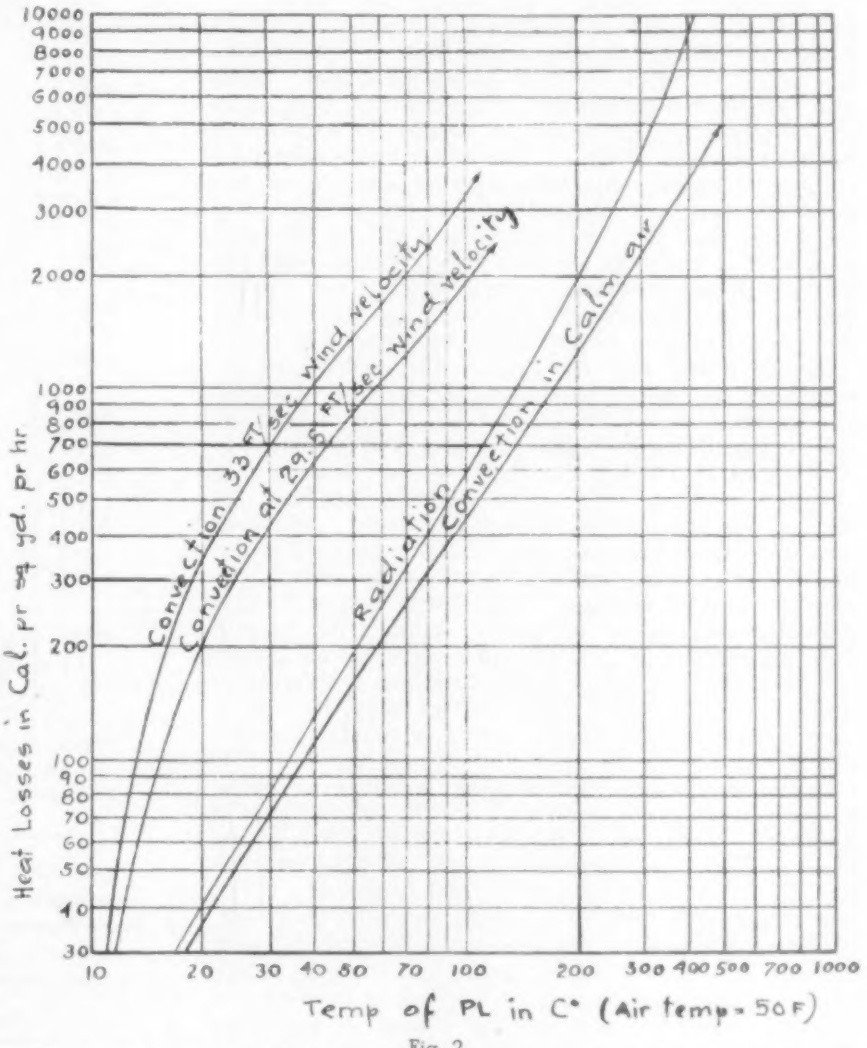


Fig. 2

This figure shows calorie losses per 10 sq. ft. per hour (1 kg. calorie-4 B.t.u.) divided into losses due to convection as well as to radiation at different wind velocities, and at a temperature of approximately 52° F.

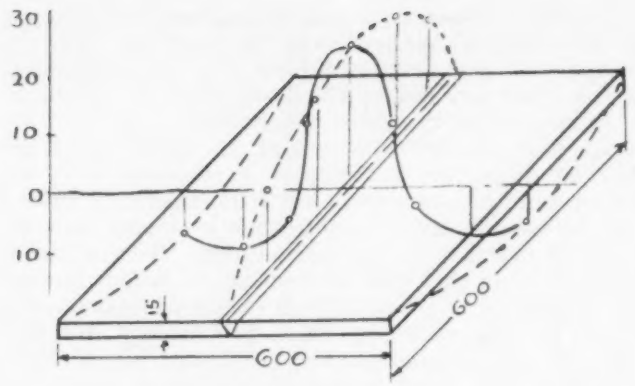


Fig. 2 (a)

plates might be considerably reduced, because the doubling plate may be given the shape of the characteristic stress pattern of such connections.

Advantages of Welding in Connection with Ship Construction

It will be of interest to analyze the weight saving obtained when comparing welded structure with riveted structure. Most of us are familiar with the saving of weight obtained when reversing shapes and welding the toe against the plate as compared with the same shapes having the flanges riveted to the plates. This results in a weight saving of about 30% alone for shapes. When using serrated members and shapes, which most of us are familiar with, the saving of weight for members is further increased to 40%. The writer has conducted a number of experiments with serrated and special serrated members, as compared with riveted members, and has found that the former possess a greater elasticity than riveted members which is also of considerable importance in ship structure. It may interest you to learn that various shipyards in the Scandinavian countries commenced making exclusive use of serrated members about 1934, and that the savings and advantages obtained by the use of this construction were manifold. For instance, the 15,000 t.d.w. type of tanker built by the Cockum Yard in Malmo, Sweden, was increased to 16,000 tons by altering the design of these vessels from riveted to welded, with special serrated members. In other words, the carrying capacity of these vessels was increased about 900 tons. For a shipowner such an increase is of great importance, because it presents a continuous source of revenue. The charter cost of a ton is generally assumed to be twelve shillings per month. Thus an addition of 1000 tons to a vessel brings £ 7992 or $28800 per year, which to the shipowner represents an additional profit, aside from the fact that the cost of maintenance for his welded vessel is considerably reduced.

In connection with the foregoing, it will be advisable to mention that the prediction of the efficiency of a proposed vessel is one of the most difficult duties of the naval architect and, incidentally, also the most interesting one. To compile all possible cost figures of a vessel and reduce same to daily expenses, and thereafter compute the earnings of the vessel based upon different charters in different routes, and when these data are finally accumulated, design a vessel so as to meet the computed efficiency, is really the essence of ship construction, because the shipyard which meets its predicted efficiency will never lack customers.

One of the most unpleasant difficulties which the designer, welding engineer and builder have to overcome during construction of welded ships, is warpings resulting from transfer of heat from the arc to the hull. In order to be able to make successful use of welding, it is necessary to know how warpings and their connected stresses arise. There are many rules as to the best manner in which to counteract warping, but all different opinions are being concentrated into one law—namely, transfer as little heat as possible and leave the ends of the material free. There is no question but that the present rules call for excessive deposit of welding material and that a sensible reduction of this can counteract the warping to a considerable extent. To this end the writer has made a number of tests and has found that with first-class coated electrodes the welding of material deposit need not exceed the area of the corresponding rivet holes specified by the Classification Societies rules plus 25%. This ratio brings us down to fillet welds of normal throat. The extent to which the deposited material fuses into the welding material is very often neglected, but experience indicates that it is of utmost importance to use comparatively heavy electrodes and high amperage and as fast traveling as practical in order to get proper fusion and minimum transmission of heat. One of the most important laws to follow when welding a ship is to analyze what influence warpings will have on the hull as a whole and to divide the hull up in suitable welding bays, welded in a predetermined sequence, in order that the stresses and warpings arising may counteract each other. The present tendency of prefabricating merchant ships, in suitable sections may be ad-

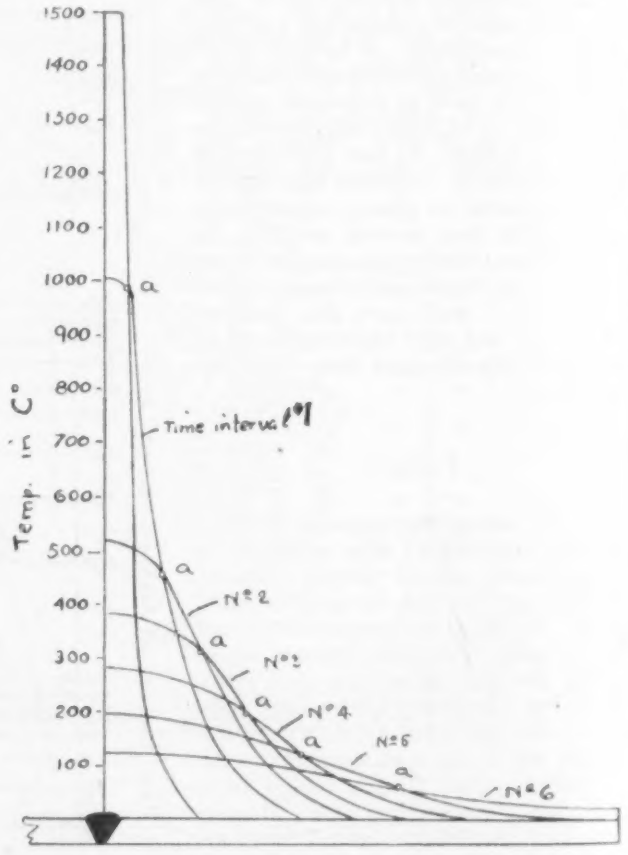


Fig. 3

This figure shows the distribution of temperature perpendicular on a butt weld at intervals of time in the area where the material absorbs elastic stresses. To the left of *a* the material has started to cool off, and stresses are present in this area. To the right of *a* the heat is still progressing, and the expansion is creating compressive stresses as expansion is counteracted by the contraction at the weld, as well as by the colder material at the edges of the plate.

visable in the present emergency, although it scares our Scotch shipbuilding colleagues. By welding the ship in sections it is, of course, possible to put a greater number of welders on each section than ordinarily could be done when erecting the ship as a whole, because too much welding material deposited on a hull in a minimum time is not satisfactory, whereas if the vessel is built up in sections the heat distribution is greater, and the possibility of welding stresses continuing into adjacent parts of the ship is lessened. The welding of ships in sections results in increased economy because of the suitability of such sections for automatic and down-hand welding.

The desirability of using serrated or castelated members in ship structures has been discussed in the foregoing, and it is obvious that this type of member aside from its many other advantages, also eliminates a considerable amount of warpage. This is due to the fact that the welding is restricted to certain areas or increments. The writer has been fortunate in having had an opportunity to design serrated framed vessels for several years, and to be on board a vessel built entirely on serrated structural members during collision, with a speed of about $11^1/_2$ knots. The damage from this collision was very slight when comparing the speed and the rocks hit. In fact, the vessel proceeded on its voyage and encountered a severe storm after the collision, without any additional damage being developed. This could hardly have taken place with a riveted ship because the rivets probably would have sheared for a considerable distance aft during the collision.

The question of cost of construction of welded ships as compared with riveted ships may be of interest. Unfortunately, the writer only possesses exact data from Scandinavian yards. Here it was found that the cost of medium sized vessels (5000 tons) based on serrated structures was reduced about 20% as compared with riveted ships of identical design. For smaller vessels the reduction in cost was slightly larger. When in addition to this reduction in cost, the owner of the vessel also derives benefits in the form of increased earning capacity of the vessel as compared with a riveted vessel and also reduced cost of maintenance, there can be no question but that welded ships are to be preferred.

The present record building of vessels may seem fantastic, but if one views the construction as man-hours it would be apparent that the number of man-hours are practically the same whether the vessel is built in 3 mo. or in 7 mo. In fact, the vessel built in 7 mo. is to be preferred, as far as workmanship and sea worthiness are concerned. Many people seem to be under the impression that launching a vessel in 10 days from keel laying represents the actual building time. This is very erroneous because the 10 days' launching time represents only assembly, that is, joining the fabricated parts which were referred to in the foregoing. In spite of this, a time of 10 days for a 9000-ton freighter is the most outstanding achievement ever heard of in shipbuilding because it demonstrates organization abilities which have been undreamed of in the shipping industry in former years.

Emergency Cargo Vessel for War Purposes

Your attention is invited to the type of cargo vessels now in use: they have excessive superstructure and rigging, which make them excellent targets for enemy submarines, because the higher a vessel extends above sea level, the greater is the radius of its visibility. Another factor to consider is that vessels with high superstructure are more difficult to maneuver owing to their wind resistance.

Modern ship design tends toward reducing superstructure or, at least, streamlining same, at the same time reducing the weight of the superstructure and improving stability.

I am suggesting, therefore, a vessel, Fig. 4, for present war emergency, on which the superstructure is entirely removed, with the exception of a pilot house, which is designed as a telescoping superstructure. An outboard profile of such a 10,000-ton vessel is shown on the slide, giving roughly the idea of the proposal. The vessel has a freeboard of approximately 6 ft., with a shear in the deck forward, but negative shear aft, creating thereby a streamline shaped deck.

The officers' and crews' quarters are below deck between the engine room hatch and the telescoping pilot house. Entrance to the quarters will be through the pilot house and through the escape scuttles.

Cargo hatches are at least 60 ft. in length and of a modern design developed by Martin Nelson, which permits easy removal of hatch beams and increases the longitudinal strength of the hatch opening, thus there will be no difficulty with the hatch construction. Most modern ports have ample cargo facilities, so that the winches and cargo booms are hardly ever used for loading and discharging cargo. Where it is necessary for the vessel to use its own handling facilities, these will be of somewhat novel design, and consist of an electrically operated crane on rails straddling the cargo hatches. The crane will be designed so that it may be dismantled and stowed below when the vessel has gone to sea, and may be easily hoisted out of the cargo hatches and mounted when the vessel is in port. It should be noted that cargo handling facilities of this type, as well as the telescoping pilot house, are nothing new, but have been tried out and used on the Great Lakes and on the East Coast.

The propulsive power of the vessel will be furnished by Diesel engines, turning about 700 rpm. These engines are to be connected to the propeller shaft by means of hydraulic couplings with gear, reducing the revolutions per minute to 220, and permitting 100% flexible connection between motor and shaft. In this connection it should be noted that modern welding permits us to build these hydraulic couplings as weldments on a regular fabricating scale.

The exhaust, after passing through spanner swirly flow exhaust boilers, developing 1 lb. of steam to each horsepower, will be passed out on the side.

The necessary auxiliary machinery for electric current and power will be Diesel.

We now have a modern vessel with freeboard in accordance with the law and regulations, but with no superstructure. The advantages are very obvious. Maximum height above sea level of guns and telescoping pilot house will be approximately 14 ft., which should reduce the radius of visibility 4.3 nautical miles. Secondly, the vessel possesses the utmost of maneuverability, and is not in any way hampered by wind resistance. The vessel is well armed and should, in fact, be able to take on a battle with any submarine.

The tremendous weight and steel saving in connection with this construction is apparent. The weight of the superstructure of an ordinary cargo vessel represents approximately 25% of the total weight, and, as the labor cost of the superstructure is one of the most important items in connection with shipbuilding, the reduced cost of construction is considerable.

Your attention is also invited to the fact that modification of a vessel like this after the war can be carried out without very much alteration to the hull itself, merely by adding superstructure to the extent which future operators might desire. This is very important, be-

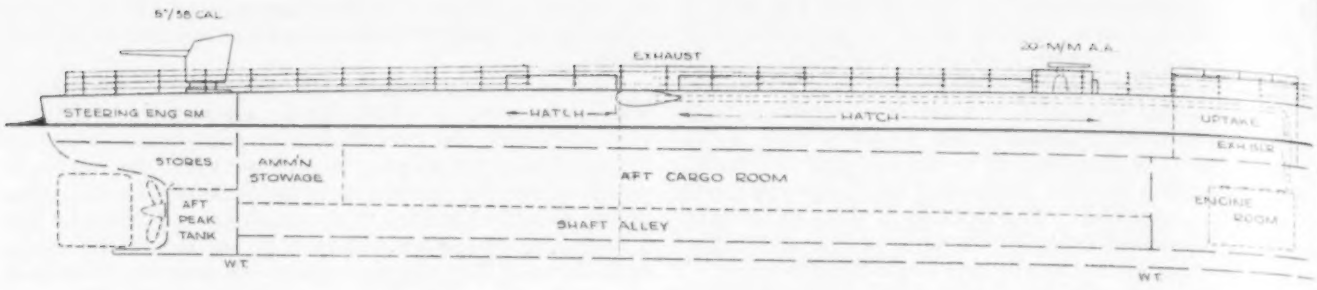


Fig. 4—Emergency Cargo

cause the present type of cargo vessels being built will require considerable alteration for peacetime operation.

PART II*

There is probably no profession or craft where the responsibility is so great as in shipbuilding, because the life of the crew and passengers and the safe conduct of the cargo a ship may carry, depend upon correct computations and plans by the engineer and how well the shipbuilder has carried out his work. When a vessel is subjected to severe storms, the hull stresses arising from these should have been anticipated and provided for by the designing engineers, and the various crafts involved in the construction should be certain that their work is well done and that no ruptured connections may occur from faulty workmanship. In many cases the stresses may exceed the yield point of the material, as was explained in Part I, and it is not infrequent that a large vessel subjected to waves of about 30 ft. in height may develop stresses of 15,000 psi. or more. In this connection it may be mentioned that the ratio between compression and tension when the vessel is in the trough or crest of a wave may be as high as one-third. For instance, the stresses in deck may be three times the compression in bottom when on the crest of a wave.

Figure 5 shows a vessel on the crest of a wave; Fig. 6 in the trough. The dotted line indicates the wave on port side while the full line shows the wave contour on starboard side. The force developed by a wave is, therefore, not symmetrical, but generally also imparts a twisting moment to the ship. Figure 7 represents the moments corresponding to Figs. 5 and 6. The moment of ship in calm water is indicated for comparison and the moment on crest of wave as well as in trough may, therefore, be measured as additional moments to the static moment when plotted as shown. The bending moment of the vessel when in a trough between two waves, is, as will be seen, considerable and, at times, three times as large as the moment on crest of a wave, as mentioned above. This ratio between bending moments must be taken into account by the designer of any vessel and serves as a reminder to the welding engineer as to the fluctuating stresses the connections of a ship are subjected to. The curves shown are plotted for a ship 430 ft. 0 in. long, 59 ft. 0 in. beam and 30 ft. 0 in. molded depth, with an approximate mean draft of 23 ft. 9 in. and a displacement of 13,000 tons. Figure 8 gives the actual deflection measured on a ship of this size in a storm where waves of up to 49 ft. in height were measured and recorded. Only part of this height is effective and this must be computed after the moments

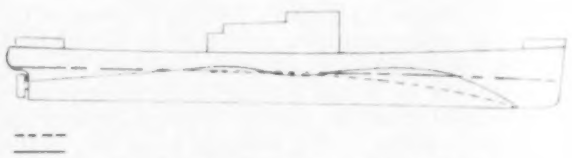


Fig. 5—Vessel on a Crest of a Wave

Fig. 6—Vessel in the Trough

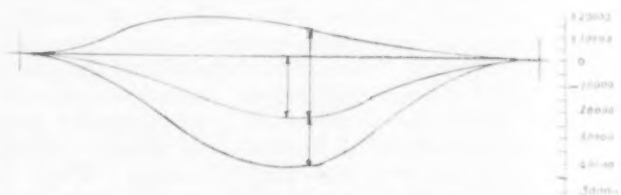


Fig. 7—Moments in Figs. 4 and 5

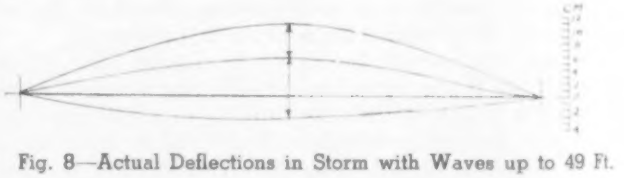


Fig. 8—Actual Deflections in Storm with Waves up to 49 Ft.

and corresponding stresses have been plotted.

The above should impress upon shipbuilders the seriousness of their work and the fact that one inferior connection only may be the cause of the loss of the ship with its entire crew and cargo, because if rupture starts it generally spreads whether the vessel is a welded one or a riveted one.

Design and Erection

The planning and computation of welded connections are carried out in the designing office; it is necessary, therefore, that the designer and draftsman have a complete understanding of not only the advantages of welded connections, but also knowledge of welding metallurgy, including stresses which may occur from warpings. The more knowledge, the greater are the possibilities for eliminating undesirable stresses inherent to welding procedure.

The planning of a welded hull is entirely different from that of a riveted hull. First of all, it is important to

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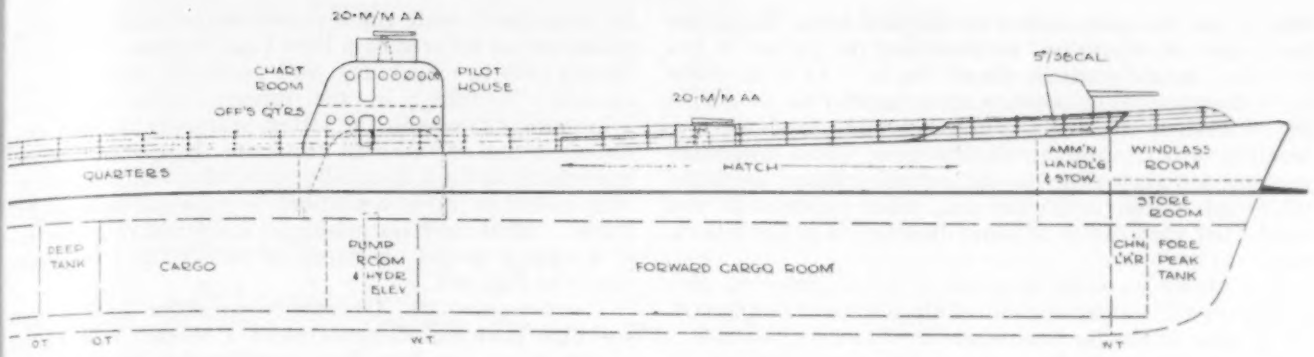


Vessel for **War Purposes**

locate the welded connections where they are most accessible. This can best be carried out by adopting prefabricated methods to an extent which is possible without jeopardizing the form of the hull. At present the fabricating method is carried too far by unskilled craftsmen, with the result that the hull form suffers and, in many cases, does not at all conform to the lines laid out in the mold loft.

First of all, the sequence of welding must be planned so that the members or fabricated parts have freedom of motion along the designed lines of the ship. Secondly, the sequence must be balanced. We could very well express this in the familiar term, heat balance, because the heat transferred to each side of the ship's center line as well as longitudinally on each side of the midship section, and vertically above or below the ship's neutral axis, must balance in order to eliminate or reduce alterations to the hull's form, i.e., lifting of bilges or fore and after ship. All welded connections must be computed as explained in Part I and by example shown by the following. There is a certain danger involved by using ordinary thumb rule for welding thickness because, in most cases, thumb rules were not developed for any particular stresses, but merely as an indication of what many welders believe is "full strength weld." It is now being gradually realized by builders of welded ships that excessive welding may become very harmful, not only as a source of locked-in stresses, but also by reducing the flexibility of the hull.

Sequence Proper

Practically all of us who have been connected with shipbuilding or structural work have had occasion to observe how steel structures are influenced by change in temperature. Anybody watching the behavior of a steel hull during construction has seen that the heat from the sun during the daytime may cause warpage of considerable magnitude; it is the duty of the shipwrights and surveyors to watch these changes and make allowance for same during construction.

When temperature changes caused by nature are sufficient to produce warpings in a hull, the heat transferred by, for instance, 100 welders striking an arc at the same time, must obviously cause considerable stresses as the heat dissipates. The heat content of steel when the welding temperature has been reduced to 1230° F., is about two calories per gram. The 100 welders working at the same time, developing a temperature of 3000° F. at their respective seams, are actually pouring calories into the hull, and as the specific heat of steel at this temperature is Cm. $\frac{\text{kg. Cal.}}{\text{kg. °C.}} = 0.165$, the rate of absorption is considerable. Thus, there is a certain limit to the number of welders which may work at one time on one hull. While this limit, of course, depends upon the size of the vessel, and how well the welding sequence has been developed, it is a factor which must be taken into consideration during the construction of a vessel. The conclusion: "more welders, more work accomplished and shorter delivery of a vessel" may sound good, but there is a danger signal which should not be passed.

In order to illustrate locked-in stresses and deformation, we shall take the following example: Suppose we butt weld two 39- x 84- x $^{7}/_{16}$-in. plates. First we compute the amount of welding material deposited. This is approximately 1.9 lb. This deposit at usual welding temperature will transfer about 1170 calories to the two plates. If this heat is given an opportunity to distribute itself over the two plates, their temperature will be increased by 150° F. Computing the contrac-

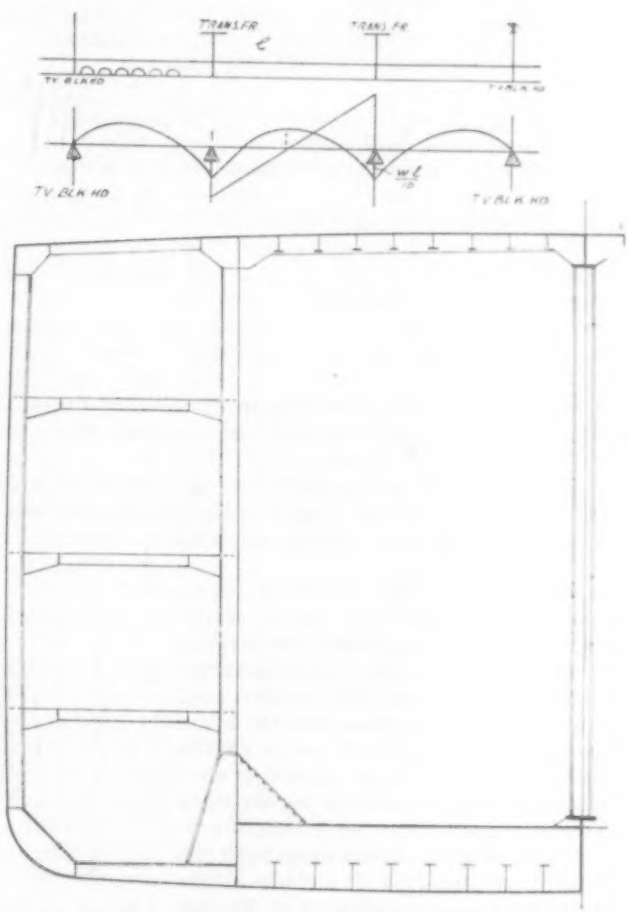


Fig. 9—Sketch of Midship Section of Tanker-Two Longitudinal Bulkheads

tion of the two plates when cooling and using the proper coefficient of expansion, we find that the plates, if free to move, would contract about $^1/_{16}$ in. As both plates have been locked in position at ends prior to commencing of welding, the stresses corresponding to above contraction will amount to 23,500 psi. These computed stresses are very close to the actual stresses measured which amounted to 25,600 psi., when experiment was conducted with plates of same dimensions in the laboratory.

The above example is referred to in order to give engineers and welders an idea of the deformations locked-up stresses of similar magnitude would cause in a hull.

Before going into the question of actual sequence, it may be of interest to analyze, for instance, the stresses occurring in a hull connection and to compute the thickness of welding actually required as compared with the classification societies' requirements.

As an example we shall compute the stresses in the longitudinal bottom framing of an oil tanker of approximate dimensions:

L.B.P. = 500 ft. 0 in.
Beam = 67 ft. 0 in.
Depth = 36 ft. 0 in.

Figure 9 shows the approximate midship section, spacing between longitudinal members in bottom = 27 in. The top portion shows spacing of transverse frames = 14 ft. 0 in. and distance from transverse frame to bulkhead = 12 ft. 0 in. Directly thereunder are the diagrams of bending moment and shearing computation giving following results:

Static load on longitudinal frame	= 40 tons
Reaction at transverse bulkhead	= 16 tons
Reaction at transverse frame	= 24 tons
Bending moment	= 1,960,000 lb./in.
Shearing force	= 53,800 lb.
Longitudinal frame = 19 x 9 x $^1/_2$ x $^5/_8$ in. Tee	S = 151.5 in.^{3}
	I = 2190 in.^{4}
The static moment, M_s	= 128.5 in.^{3}
Allowable shearing stress in weld, f_s	= 6800 lb./in.
Average shearing force each end of frame	= 40,000 lb.

$$\text{Formula No. 1: } f_s = 6800 \text{ lb./in.} = 1.25 \frac{V.Ms}{a.\ I.}$$

when

V = web shear = 40,000 lb.
M_s = static moment
a = throat of weld
I = section modulus

Solving Formula No. 1 with respect to a = throat of weld gives us a continuous weld and each side of the toe of $^1/_4$-in. throat for a length of 4 ft. 0 in.

Using same formula to determine the throat of welding required for 6 ft. 0 in. length in the middle, the frame gives us a continuous welding on both sides of $^1/_8$-in. throat.

It will be seen that this is the same method used in order to arrive at the proper riveting for identical connections, only that we have added 25% as factor of safety for corresponding welded connection. My contention, which I am fortunate in sharing with some of the classification societies, is, therefore, that it is unnecessary to increase the strength of welded connections above that of corresponding riveted connections with the exception of the 25% I include in the computation as a possibility of human error.

A comparison between vessels welded in accordance with rules permitting minimum welding thickness, as referred to in Part I and welded vessels built during present emergency, will prove the foregoing conclusion. Warpings in the former are reduced to a minimum, whereas in the latter, warpings are very pronounced, and in order to eliminate these the heat and quenching method is usually resorted to, with the result that locked-in stress conditions become still more aggravated. Heat and quenching as a method of correction of warpings should, therefore, be reduced to a minimum (see also Fig. 10).

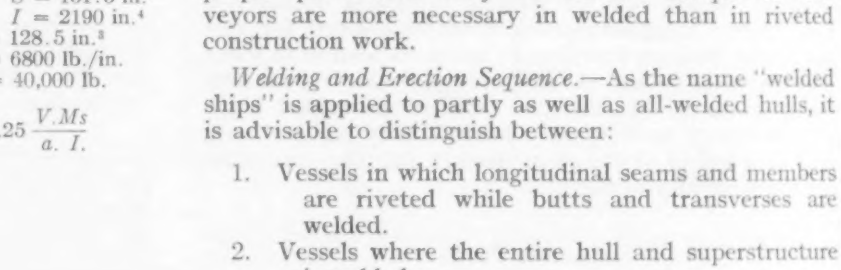
Compensation for Shrinkage.—In order to maintain specified principal dimensions of a welded hull during construction, the item first considered is allowance for shrinkage (see Fig. 11). The following allowances have been compiled from the construction of a number of welded vessels:

1. Flat keel laid out with $^1/_{32}$ in. allowance for frames (frame spacing plus $^1/_{32}$ in.). For each transverse bulkhead $^1/_{16}$ in., and each butt, $^1/_8$ in. shrinkage.
2. For the first continuous deck the shrinkage caused by welding transverse bulkheads to same is reduced to $^1/_{32}$ in., and for deck beams, to $^1/_{64}$ in. This is because the welding material deposited under a nonstrength deck is less than for bottom structure.
3. As fore and after peak in modern shipbuilding is fabricated separately on the skids, an extra allowance of $^3/_8$ in. is generally taken for the fore peak and $^1/_4$ in. for the after peak.
4. For ships with several decks the shrinkage is computed in advance for each deck and a proper balance both for heat transmitted and shrinkage caused by same, is entered in the welding procedure.
5. It is of the utmost importance that hull surveyors are continuously on the job and check all measurements; any undue shrinkage should immediately be reported to the naval architect or welding engineer in order that proper precautions may be taken. Competent surveyors are more necessary in welded than in riveted construction work.

Welding and Erection Sequence.—As the name "welded ships" is applied to partly as well as all-welded hulls, it is advisable to distinguish between:

1. Vessels in which longitudinal seams and members are riveted while butts and transverses are welded.
2. Vessels where the entire hull and superstructure is welded.

Regarding (1), it is obvious that a combination of welding and riveting invites difficulties. I am referring particularly to subpunching of the seams, as it is next to impossible to obtain proper alignment of the rivet holes when the butts have to be welded first. The



Proper sequence of welding for insert Plates

Fig. 10

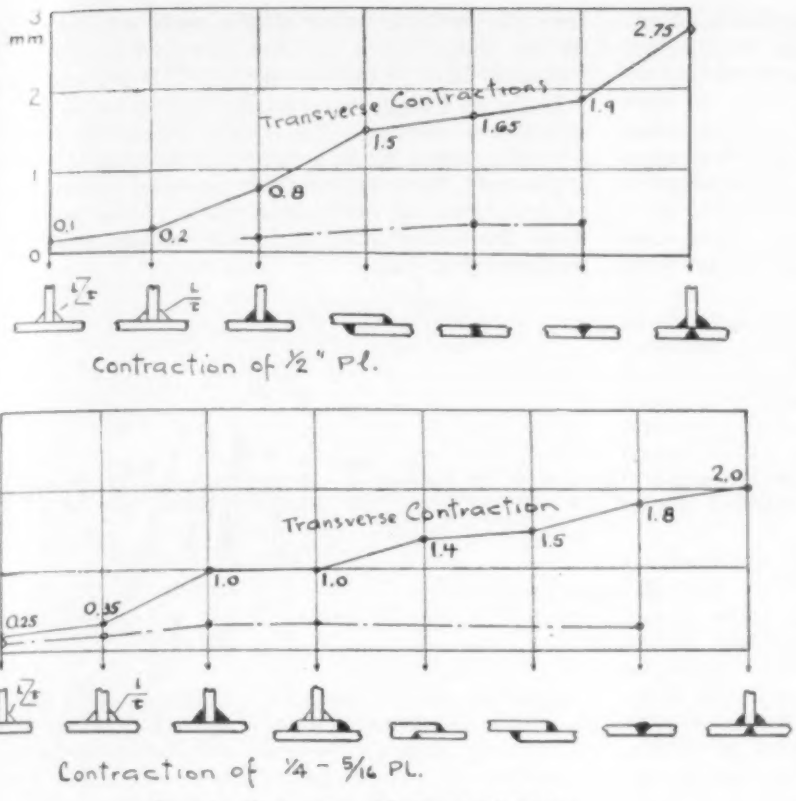


Fig. 11—Contraction of Butt and Fillet Joints

only remedy is to drill one plate strake for at least one-fourth of the length of the vessel at each end, and for fine vessels, for one-third of the length at each end. It is understood that riveted frames are hardly considered by a modern yard, because they would eliminate the weight saving inherent to welded vessels.

Regarding (2), the all-welded hull not only results in the greatest weight saving, but lends itself better to fabrication and effective construction.

The Erection and Welding Sequence for a vessel may briefly be summarized as follows:

1. Dividing the hull into a suitable number of berths and these into bays, in order that the erection, as well as welding, may be carried out in orderly sequence.
2. The parallel midship up to the first continuous deck generally constitutes berth No. 1.
3. The section forward of said midship body is either kept as one berth or divided into two if the fore peak is fabricated. Thus we have berths No. 2 and No. 3 forward.
4. Likewise the after body and stern are divided into two or more berths, i.e., berths No. 4 and No. 5.
5. The structure between main and superstructure decks generally constitutes berth, No. 6, and the superstructure one berth, No. 7.

The larger the vessel, the larger the number of berths required. A proper division into bays depends largely upon the welding analysis and the desirability of keeping a proper heat and shrinkage balance during welding.

Even with the most carefully worked out welding sequence there will be a tendency of the bow, stern and bilges to lift. It has become customary, therefore, to allow about 1-in. lift at bow and stern and about $^1/_2$ in. at bilges by prealignment. The keel and bottom plating are laid out to the extent possible, cased up, and butts welded first, whereafter the seams may be Unionmelt welded. In cargo ships with double bottoms this is built in sections on the skids and constitutes the first berth. It is of the utmost importance that keel and bottom plating have been given the shrinkage allowance referred to in the foregoing and that the welding, after proper alignment, proceed as evenly as possible on each side of the keel, preferably in a diagonal position. The surveyors will check alignments before and after welding. On small vessels it is desirable to erect and tack weld the entire hull before commencing continuous welding. This permits Water tight and Oil tight welding to be carried out on night shifts which is preferable due to less interference.

The shell berths being erected in their proper sequence from bottom plating or double bottom and up, or built as erection units on the skids to the extent possible, are welded with respect to the neutral axis of the vessel—or unit, if fabricated, in order to equalize longitudinal shrinkage which has been taken care of by the allowance referred to. The construction of each berth is observed carefully by the surveyor and transit shots taken at intervals.

The erection and welding should progress uniformly on each side of center line and interior structure hoisted in place at the most opportune moment during construction. The interior hull structure forms the welding bays proper and after tacking same, the continuous welding should progress symmetrically as described in the foregoing, and preferably diagonally, on each side of center line. Every other bay should be completed first, the welder returning to skipped bays in a manner analogous to back-stepping.

In Scandinavian shipyards it has been customary for the last 6 yr. to build the fore and aft peaks on skids and erect same completed against the fore and after peak bulkhead which extended outside the shell. While this method may sound radical, it has proved very successful because the usual knuckle of the shell around the bulkhead is eliminated, making correct, smooth bowlines possible and cutting time of erection. The danger of laminated plating in this method is exaggerated as the outside welding permits a perfect fusion of shell to bulkhead. The protruding part of the bulkhead is chipped off after welding is completed. In construction of modern tankers this method has been followed successfully by also extending transverse bulkheads through the deck plating and, to my knowledge, no case of flaws due to laminated plating has been observed, although several 16,000 tons dead weight tankers have been constructed in this manner.

Prior to closing up the decks in a tanker, for instance, all cargo oil piping should be in place and be welded to the transverse bulkheads. The type and arrangement of cargo oil piping has undergone considerable change in late years. The ring system is generally adopted and welded pipe sleeves through bulkheads have replaced heavy bulkhead fittings. The question of cargo oil piping brings us to a rather interesting problem: The cargo oil pipes in a large tanker are from 12 to 16 in. in diameter and thus possess a considerable amount of strength. This strength should really be incorporated in the ship structure, and I have, therefore, suggested replacing pipes with ducts welded to the bottom of the vessel and utilizing these ducts as cargo oil piping. Said ducts to be made of the same plate thickness as the

bottom plating, and would constitute longitudinal members of considerable strength. One of the classification societies has already agreed to accept ducts of this description as longitudinal members.

Continuing with oil tankers, the superstructure should be given a streamline form and designed so as to permit free passage over main deck. The remarkable feature with welded ship construction is that the most modern form and pleasing lines also result in the least expensive construction, and curved surfaces always have a possibility of absorbing stresses.

It is generally accepted that superstructure, such as deck houses, etc., should be welded without a bounding angle, which is inherent to riveted construction. It has been my experience, however, that the welding of sharp edges of the deck plating generally causes warpings and locked-in stresses, but that the use of the old fashioned bounding angle practically eliminates these stresses and keeps the deck straight. The use of bounding angles is therefore recommended.

While welded shipbuilding in Southern California is greatly favored by climatic conditions, there nevertheless exists the possibility of convection caused by changing temperatures and high wind, particularly in the morning hours. In my opinion, precautions should be taken against the possibility of convection during these hours, either by having the welders work in the interior of the vessel or, if working outside, protected by shields, because wind and changes in temperature often may cause rapid cooling which is not anticipated, and which is evident from Fig. 1 in Part I, at which time this question was thoroughly discussed.

There is a certain danger of overdoing fabrication methods at the expense of man labor hours. It is rather obvious that when fabricated parts have to be forced into place the result is locked-in stresses and a hull which is not in accordance with the outlines of the plan. Furthermore, the usual precautions of eliminating all warpings by application of quenching is not exactly recommended, because any warpings straightened in this manner necessarily must leave stresses locked up in the adjacent parts of the hull. After all, the forces brought to bear on such warpings do not dissipate from the hull together with the heat transferred to same, but remain in the hull itself as a potential source for later trouble. While the 100% fabricated ship construction method of welded ships is generally considered something new developed during stress of war, it may interest you to learn that Swan & Hunter's plant at Newcastle in 1935 built a 4000-ton tanker which was entirely fabricated in sections up to 150 tons each. There is no question but that the 100% fabricated method, if planned with extreme exactness and based upon very carefully built jigs, can be successful. On the other hand, inexactness with this method and careless handling of the fabricated sections invariably will be the source of inexact hull construction and possibly inherent weakness in same.

Having given a brief sketch of the sequences of welding of the hull, it is recommended that special attention be given to the welding table for same. It is the writer's contention that the welding table should be worked out for each hull and that this table not only should give the size of the weld, the size of the electrode, but also the amperage. With the unskilled welders available at the present time it seems only reasonable that all possible advance information should be given before commencing the work. The size of the weld required by the American Bureau of Shipping and by the Navy is, in the writer's opinion, excessive, and is referred to in Part I. There is really no logic in introducing so-called "full strength" welding, when all plating in a vessel is based on the classification societies' rules for riveting. It is known to all of us that the plate thickness is excessive.

In Part I I suggested a special type of vessel suited for the present warfare. I now take pleasure in presenting a built-up propeller as a future job to tackle for welding engineers. My design for this propeller type dates back to 1933, but has never been made public before 1943, when the conservation of bronze became of major importance (Fig. 12).

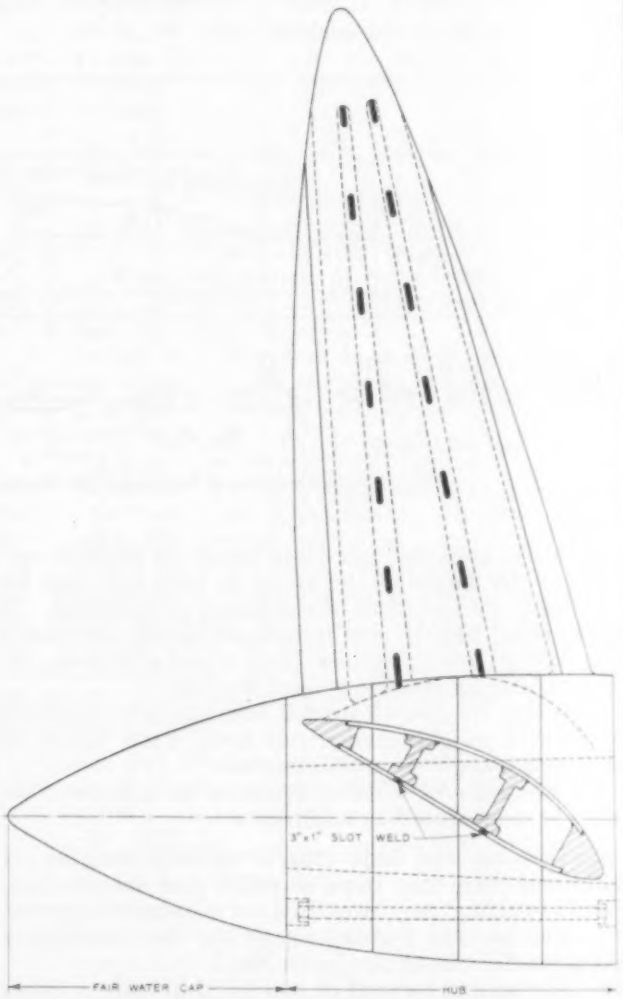


Fig. 12—Welded Propeller

The illustration indicates a propeller hub cast in four sections. Each section is cast with four fins—if a four-bladed propeller. Thus the fins on the foremost section constitute the leading edge of the propeller blade, the fins on the aftmost section, the trailing edge and the fins on each of the intermediate sections act as reinforcements of the respective propeller blades. It is obvious that sections of this type are easy to cast on account of the comparatively small mass of material involved, and simplified mold work. The sections are machined and fitted together so that the fins conform to the form of the respective propeller blades, after which the keyway, corresponding to same in taper of tail shaft, is milled.

The propeller is now ready for cover plates which are bent to approximate shape before attached by welding to the fins. The back plate is welded on first, the plate being wedged firmly to the fins by jig or quilt bolts in slots shown on sketch. The face plate is thereafter

welded on in the same manner, care being taken that the plate is always welded to the leading and trailing edge last. The propeller tips may now be welded over and the blade smoothed off.

It is obvious that cover plates forming the plates proper may be of corrosive-resisting steel, or boiler material. An analysis of the blade section gives ample strength at normal blade thickness fractions. If desired, the fins may be cast or forged separately and welded to the hub. By extensive use of special jigs, propellers of this type may be built for less than half the cost of bronze propellers. Their upkeep must necessarily also be less as damage of one blade, for instance, is merely local and sections may be replaced.

Arc-Welded Table for Oxyacetylene Cutting*

By Charles Apacki†

IN ALL plants of the R. G. LeTourneau, Inc., manufacturers of heavy grading equipment, we repair and build everything we possibly can with arc welding. Besides the actual manufacturing operations, arc welding plays an important part in maintenance and production work.

We were badly in need of a oxygen-acetylene cutting table in our maintenance welding shop; one that we could place a piece of plate steel on so that it would lie flat and we could cut out repair parts and shaped pieces and even cut clear across without moving the piece or ruining the table.

Having some short scrap ends of tubing left over from our maufacturing operations, we took nine pieces of 9-in. tubing, cut them each 18 in. long and set them up on end on a flat surface. Then with our arc welder we tacked them all together, three each way in a square unit (See Fig. 1.)

Then using some scrap $^1/_4$ x 2 x 2 angle iron, we made a square frame and welded four pieces of $2^1/_4$-in pipe 18 in. long on the bottom of frame for legs. Setting the pipe unit into the frame, we have a cutting table 27 x 27 x 36-in. high. The size can be optional—more pipe, bigger table. (See Fig. 2.)

Material cost amounted to only $2.31, labor $4.95—total $7.26. Without arc welding, the cost would have prohibited building such a table.

When the top of the table gets rough and cut up from use, turn the pipe unit over and you have a new surface. When this, too, gets rough, break welded tacks from the pipe and cut about 2 in. from ends of each pipe and tack weld the pipes together again for several more months of service.

The table is clog-free and scrap and slag can easily be removed from under it with a shovel. It is also safe for the welder, the pipes guiding the sparks and slag straight through to the floor.

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*This was one of the prize-winning awards in the Monthly Arc Welding News Contest conducted by The Hobart Brothers Co., Troy, Ohio.

†R. G. LeTourneau, Inc., Maintenance Welding Foreman, Peoria Plant.

Fig. 1

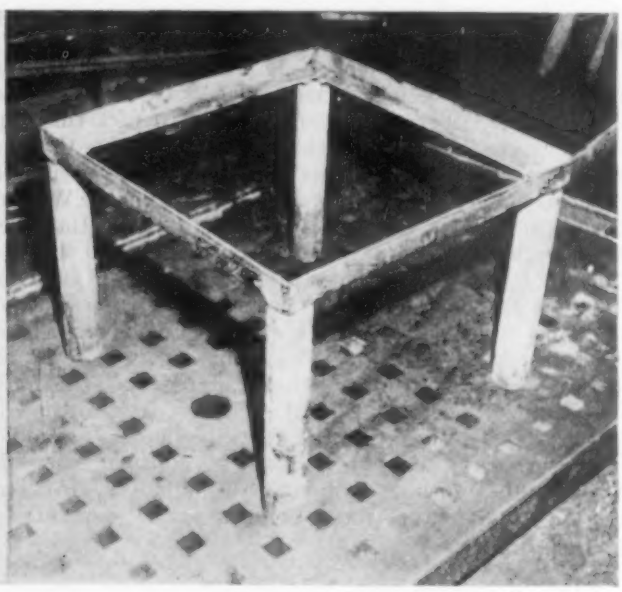

Fig. 2

Arc Welding in Airplane Boiler Fabrication*

By H. A. Lebert and S. B. Willoughby†

UNITED Airlines as one of the leading users of DC-3 (Douglas) air transports has long been aware of what might be called a "weak link" in this airplane's makeup, namely: the heating system and more specifically the boiler unit of that heating system.

The DC-3 has always used the "steam" system wherein water is converted into steam by contact with metal which has been heated by the engine exhaust gases. The steam is conducted to a tubular radiator inside the airplane and gives up its heat to a stream of air brought in through a "nose door" located in the nose of the plane's fuselage and carried through the radiator by means of ducts to the various parts of the plane's interior. The steam condensate is returned to the boiler and again converted into steam.

Suitable valves and regulators are used to maintain about 15 lb. steam pressure throughout the system. A surge tank serves as a reservoir to compensate for varying demands on the system.

The radiators give practically no trouble in service; the valves and piping give average or expected service while the boilers, as mentioned before, are the "weak link" in the heating system.

The original Douglas factory boiler was of tubular construction using some 18 tubes of varying length by 1/2 in. diameter and made of stainless steel. These tubes were welded to suitable headers and located in the path of the exhaust gases from the engine. Water was fed into the lower header or sump and converted into steam as it contacted the exhaust heated tubes. The steam thus formed was conducted to the radiator where it gave up its heat to the incoming fresh air for the cabin. The resulting condensate was returned to the boiler to be used again.

This type boiler which we shall refer to as the tubular type boiler has been used with success by some airlines, notably the American Airlines, Inc. In fact this type boiler was so improved by the use of arc welding that two members of American Airlines Personnel won well-deserved awards from The James F. Lincoln Arc Welding Foundation. In view of such improvement the question might well be asked: "Why a different type of boiler?" The answer lies in the fact that while all Douglas DC-3 airplanes are like so many peas in a pod in many respects, there is, however, one important difference between the DC-3 equipment as used by the various leading airlines. That difference is the make and type of engine used. To clarify: American Airlines uses the Wright, single-row, 9-cylinder, air-cooled engine whereas United Airlines in contrast uses the Pratt and Whitney twin-row, 14-cylinder, air-cooled engine. Since both these engines give off plenty of hot exhaust gases for boiler heating, the question is fair: "What difference does it make which engine is used?" The answer is vibration. The periods of vibration encountered with the use of the twin-row (14-cylinder) engine while smoother to the passengers nevertheless are anything but friendly to the stainless steel tubes in the tubular type boiler. The welds did not fail under vibration but the tubes did. Seams would open in the bends of the tubes with clock-like regularity after about 100 hr. service.

Thus it can be seen that the answer to one airline engineer's prayers is not necessarily the answer to some other airline's problem.

In order to combat this "demon" vibration, one of the writers (H. A. Lebert) early in 1938 designed what is known as the United Airlines Corrugated Boiler. This design did not permit vibration of any of its parts yet provided flexibility to compensate for wide extremes of temperature with attendant expansion and contraction. The first units were made in a drop hammer as stampings, i.e., sheets of stainless steel were formed into half-tubes, placed between male and female dies and the corrugations stamped one at a time. Then the two half-tubes were trimmed to match and *gas welded* on each side to form a continuous corrugated tube. This tube formed the core of the boiler. Two similar stampings but with shallower corrugations were then stamped, fitted and welded on the outside of this core to form the boiler shell or jacket. The hot exhaust gases from the engine came in contact with the core thus heating and converting into steam the water which was introduced between the core and the jacket. The finished boiler looked very much like the boiler shown in the accompanying photographs. It was a success in combating vibration and gave at least twice the

Fig. 1—Forming Stainless Steel Sheet

* Second Prize Award Paper in Class B-2, Aircraft, Fuselages Division of the 1940-42 Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

† Inspector and Arc welder, respectively, United Airlines Transport Corp., Cheyenne, Wyoming.

Fig. 2—Blanks Are Clamped Into Welding Fixture with Copper Backing Plate

service life previously obtained from the tubular type boiler.

The stamped, gas-welded, corrugated boiler was, in brief, a decided improvement in cost and service over the tubular type boiler for use on twin-row engined DC-3 airplanes. However, the writers were not satisfied. The two welds on either side of the core represented a lot of welding that was not easy to get at. The two stamped halves of the core had to be trimmed to fit—a waste of material and time. The service time ceiling, we felt, could be raised.

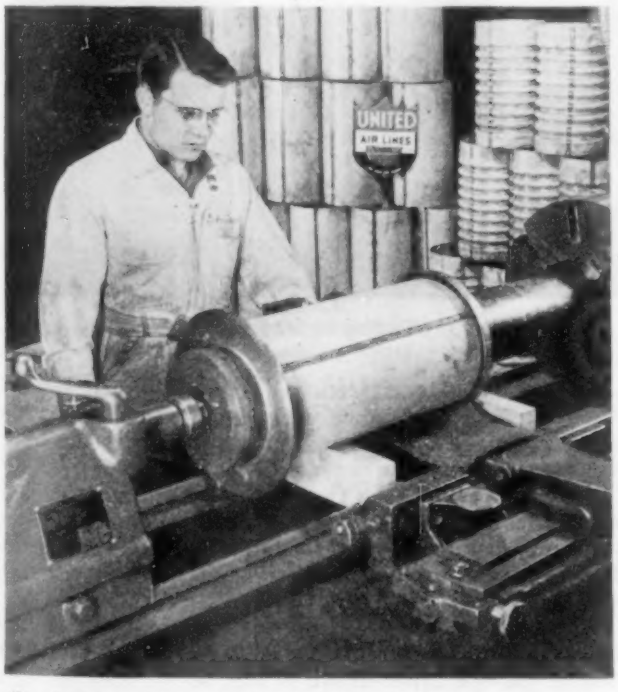

Fig. 3—Boiler Core Blank in Position on Roll for Corrugation

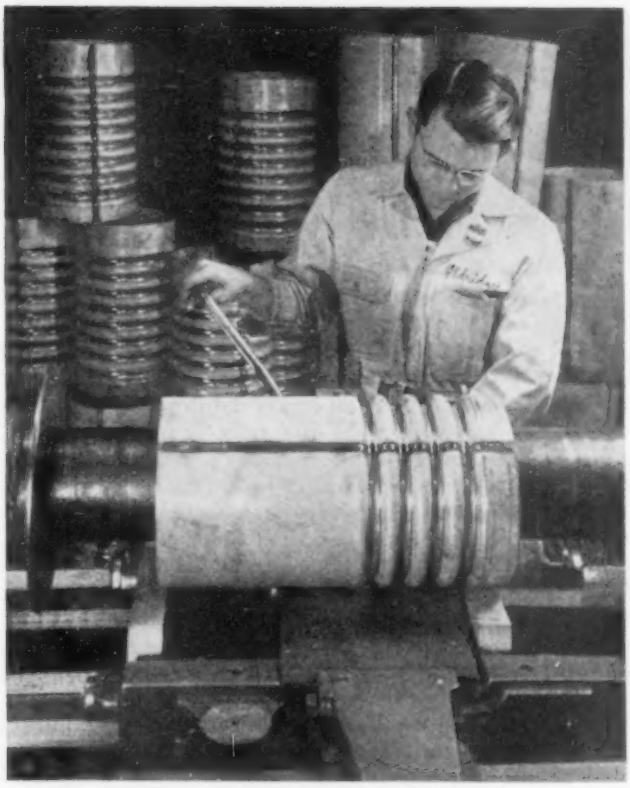

Fig. 4—Arc Welded Seam Withstands Roll Forming Action

This thought kept recurring: why not roll a sheet of stainless steel into the correct size tube and then roll the corrugations into this tube? So it was that early in 1940 we started on the process that has evolved into the present sequence as shown in the photographs with this paper. Through the use of arc welding we have reduced the manufacture of corrugated boilers to its simplest form. The least expensive type of 18–8 stainless steel was found to last almost as long as the more expensive types. Labor operations have been reduced to a minimum.

Figure 1 shows the first forming of the 0.050-in. thick stainless steel after being cut into the proper size. Core

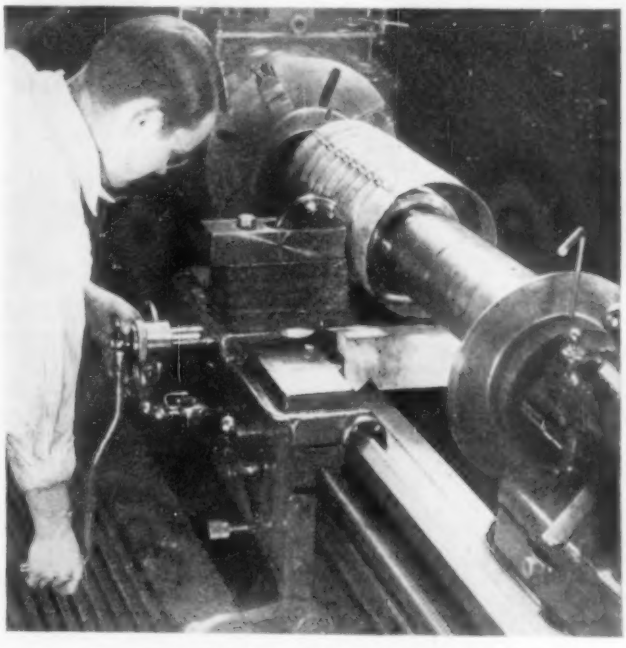

Fig. 5—Another View of the Rolling Operation

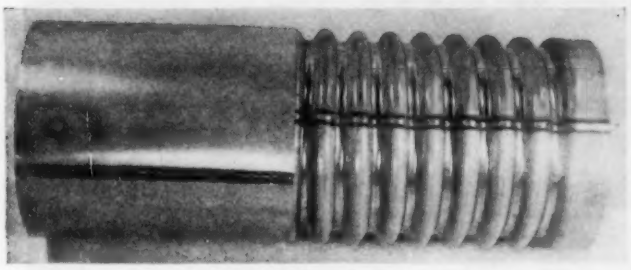

Fig. 6—Finished Core with a Welded Shell Blank

blanks are here being rolled into tube form. Each blank in the flat is 18 x $28^{13}/_{32}$ in. so that when a standard factory stock sheet (36 x 120 in.) is cut down the center we avoid waste material as the trim is used to make the upper and lower sump blanks (6 x 12 in.). The outer shell for the boiler is likewise formed into a tube before it is welded. The shell blank is $11^{1}/_{8}$ x $29^{7}/_{32}$ in. The attachment lugs and the steam outlet neck use up the narrow trim strips so none of the metal is wasted.

After the core blanks have been rolled into tube or pipe sections they are clamped into the welding fixture shown in Fig. 2.

The supporting pipe shown in Fig. 2 has a copper backing plate to back up the weld and to dissipate excess heat. Two heavy spaced bars provide a clamp for holding the core in position. The core is first tack welded in about a dozen places and then a continuous weld is made as shown. Stainweld A rod gives good penetration and forms a *ductile weld*—the heart of this method of boiler fabrication. After the flux and some of the surplus weld have been removed we are ready for the rolling machine.

Figure 3 shows a boiler core blank in position on the roll and ready for having the first corrugation formed. End plates held in position on the roll proper by set screws, accurately locate the position of the first corrugation. These end plates also serve to keep the first corrugation at true right angles with the core. The first corrugation is important as it forms or provides the "lead" or master guide on which all the other corrugations are patterned.

A light coat of oil is put on the inside of the core blank before it is placed on the roll. No lubrication is used on the outside.

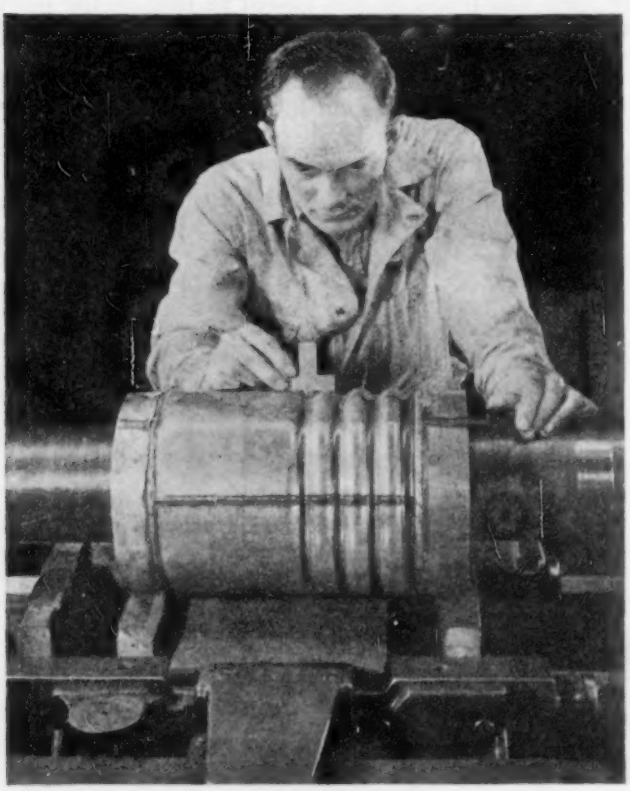

Fig. 7—Corrugation Being Rolled Into the Shell

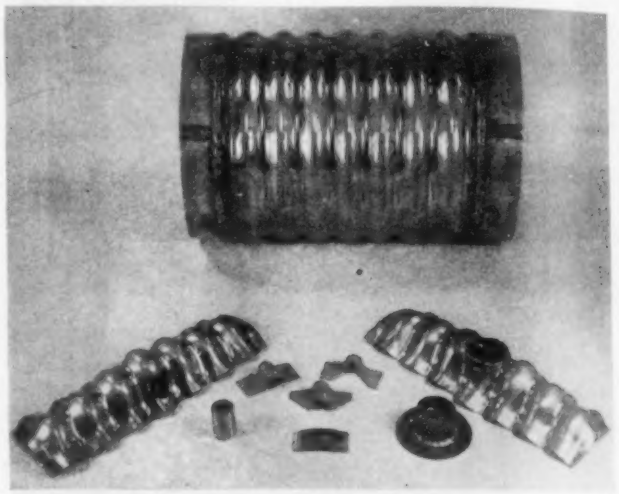

Fig. 8—Component Parts of the Boiler

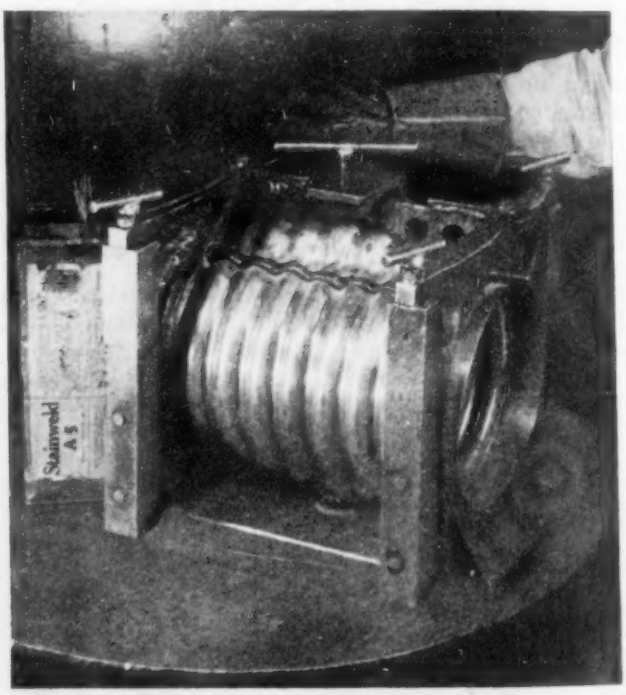

Fig. 9—Welding Jig for Assembly Parts

After the first corrugation has been formed the end plates are removed since each corrugation now being rolled is guided and spaced by the last preceding corrugation riding on the outer groove of the main roll.

In Fig. 4 can be seen the terrific punishment the arc-welded seam is subjected to. The ability of the arc weld to withstand this roll-forming action is what makes this inexpensive, efficient method of boiler fabrication possible.

Since the rolling operation is the "heart" of this method of boiler fabrication we have added the extra view of the operation shown in Fig. 5.

The standard depth of the corrugation is $^{1}/_{2}$ in.

Fig. 10—Inspection of the Boiler

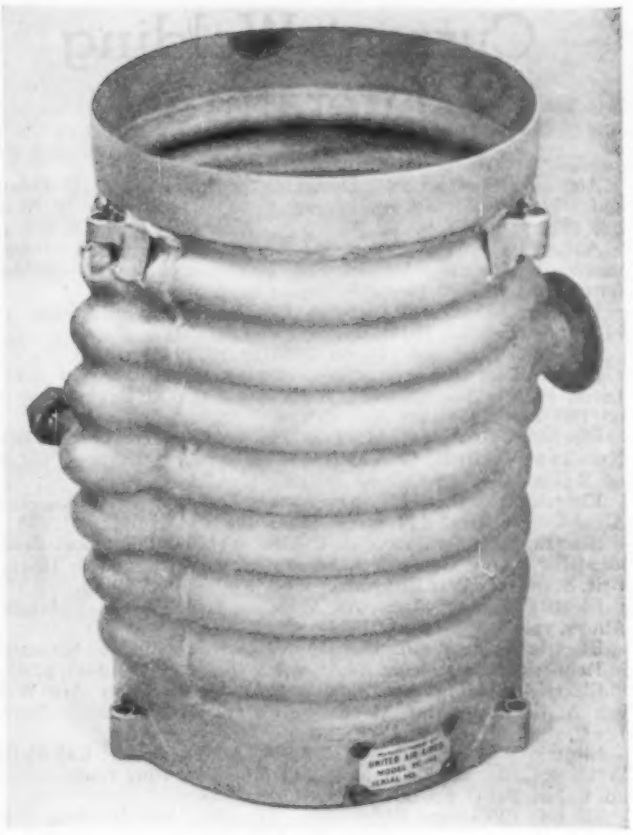

Fig. 11—Finished Boiler Ready for Installation

The operator secures this depth by reading the indicator on the feed screw. In addition he uses a depth gage as occasionally some lots of sheet stock are harder than others with a corresponding greater amount of "spring back."

Figure 6 shows a finished core with a welded shell blank about to be slipped into position over the core. After the shell blank is in position on the core the shell ends are arc welded to the core and the assembly again placed on the roll as shown in Fig. 7.

In Fig. 7 we have the corrugations being rolled into the shell. The shell and core corrugations have to match as the core is being guided by the inner roll grooves. The shell corrugations are only $^{5}/_{16}$ in. deep but the arc welds are subjected to considerable tension since both ends of the shell are welded to the core with the result that the shell is really being stretched into place whereas the core could pull metal from the unrolled end during its forming or "corrugating" process. Note how the core weld has "left its mark" on the shell surface thus showing the extreme pressures that weld and metal are subjected to.

Figure 8 shows the component parts of the boiler at this stage of assembly.

The shell has had elongated holes burned through at each corrugation. These elongated holes will permit the steam, which will form between the shell and the core, to escape into the upper or steam sump. An equal number of holes but much smaller in size have been made in the side of the shell directly opposite the steam vents. These smaller holes permit the water to pass from the lower or water sump up into the space between the shell and the core. It will be remembered that the core corrugations are $^{1}/_{2}$ in. deep while the shell corrugations are $^{5}/_{16}$ in. deep. It is the space thus created that acts as the steam forming chamber.

The sump in the lower left-hand corner is the water sump and will have the pipe threaded boss welded into it while the sump in the lower right-hand corner will have the steam outlet flange welded into it.

The lugs for attaching the boiler to the airplane exhaust pipe are shown in the lower center directly above the boiler's nameplate.

The welding jig shown in Fig. 9 is used for the assembly of sumps, steam outlet flange, water inlet fitting and attaching lugs in accurate position on the boiler core and shell. Such assembly, of course, makes all boilers readily interchangeable on any airplane.

Inspection of the boiler, Fig. 10, is made after it has been sandblasted to remove all weld flux. The boiler is plugged at the steam outlet connection and connected to an airline at the water inlet fitting. Under 110 lb. air pressure the boiler is submerged under water for the detection of any flaws or pinholes. If any are found they are welded and the boiler again tested under pressure.

Figure 11 shows the finished boiler ready for stock or installation on an airplane. It weighs slightly under 15 lb. as compared to approximately 30 lb. for most tubular type boilers.

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Sections—CHAIRMEN, SECRETARIES, AND REGULAR MEETING DATES

ATLANTA — 1st Fri.

SECRETARY—J. V. TURNER, Air Reduction Sales Co., 336 Spring St., N. W., Atlanta, Ga.

BIRMINGHAM — 3rd Fri.

CHAIRMAN—C. C. PINCKNEY, Birmingham Boiler & Eng. Co., 41st St. & 8th Ave., North, Birmingham, Ala.

SECRETARY-TREASURER—W. L. POOLE, Air Reduction Sales Co., 2825 N. 29th Ave., Birmingham, Ala.

BOSTON — 2nd Mon.

CHAIRMAN—F. W. DAVIS, E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass.

SECRETARY—P. N. RUGG, 22 Eastern Ave., Wakefield, Mass.

CANAL ZONE — 1st Tues.

CHAIRMAN—CLIFFORD B. JONES, Box 533 Diablo Heights, Canal Zone

SECRETARY—JAMES G. MURRAY, Panama Canal, P. O. Box 623, Diablo Heights, Canal Zone

CHATTANOOGA, TENN. — 1st Wed.

CHAIRMAN—P. O. LEACH, Combustion Engineering Co., 1032 W. Main St., Chattanooga, Tenn.

SECRETARY-TREAS.—R. G. WILSON, National Cylinder Gas Co., 1410 Cowart St., Chattanooga, Tenn.

CHICAGO — 3rd Fri.

CHAIRMAN—R. L. KOMLBRY, Machinery & Welder Corp., 312 N. Loomis St., Chicago, Ill.

SECRETARY—T. B. JEFFERSON, *The Welding Engineer*, 506 S. Wabash Ave., Chicago, Ill.

CINCINNATI, OHIO

CHAIRMAN—TOM RAFTERY, The Linde Air Prod. Co., 2506 May St., Cincinnati, Ohio

SECRETARY—ERNEST F. CAHN, Ohio Valley Sales Co., 3018 Robertson Ave., Cincinnati, Ohio

CLEVELAND — 2nd Wed.

CHAIRMAN—R. J. KRIZ, James Herron Co., 1360 W. 3rd St., Cleveland, Ohio

SECRETARY-TREAS.—A. LESLIE PFEIL, Universal Power Corp., Cleveland, Ohio

COLUMBUS, OHIO — 2nd Fri.

CHAIRMAN—J. L. PURDY, Buckeye Steel Casting Co., Columbus, Ohio

SECRETARY—G. S. HERRRN, The Seagrave Corp., Columbus, Ohio

CONNECTICUT — 1st Tues.

CHAIRMAN—B. H. PERRY, Bigelow-Sanford Carpet Co., Thompsonville, Conn.

SECRETARY—J. IMPERATI, American Brass Co., Ansonia, Conn.

DETROIT — 1st Fri.

CHAIRMAN—HENRY C. NEITZEL, Whitehead & Kales Co., 58 Haltiner, Detroit 18, Mich.

SECRETARY—G. N. SIEGER, S-M-S Corp., 1165 Harper Ave., Detroit, Mich.

HAWAII — Last Thurs.

CHAIRMAN—GEORGE GLOVER, W. A. Ramsay, Ltd., Honolulu, T. H.

SECRETARY—ALAN G. SLIPPER, Hawaiian Gas Products Co., P. O. Box 2454, Honolulu, T. H.

INDIANA — 3rd Fri.

CHAIRMAN—J. R. WIRT, Process Dept. Delco-Remy Div., Gen. Motors Corp., Anderson, Ind.

SECRETARY—GEO. MANN, J. D. Adams Co., Indianapolis, Ind.

KANSAS CITY, MO. — 1st Tues.

CHAIRMAN—EDGAR H. FINLAY, Finlay Engineering College, 1001 Indiana Ave., Kansas City, Mo.

SECRETARY—DUANE DE BRUNNER, Columbian Steel Tank Cor., 1509 W. 12th St., Kansas City, Mo.

LAKE SHORE

CHAIRMAN—FRED HERBST, JR., McMullen & Pitz Construction Co., 923 Commercial St., Manitowoc, Wis.

LEHIGH VALLEY

CHAIRMAN—J. W. KENWORTHY, 113 N. 11th St. Allentown, Pa.

SECRETARY—JULIUS NAAB, Ingersoll-Rand Co., Phillipsburg, N. J.

LOS ANGELES — 3rd Thurs.

CHAIRMAN—DAVID C. BISBEE, Rheem Mfg. Co., 4361 Firestone Blvd.,South Gate, Calif.

SECRETARY—E. O. WILLIAMS, Victor Equipment Co., Los Angeles, Calif.

LOUISVILLE — Last Tues.

CHAIRMAN—THEODORE H. LEWIS, Jeffersonville Boat & Machinery Co., Louisville, Ky.

SECRETARY—WILLIAM DETTMAR, American Air Filter Co., 215 Central Ave., Louisville, Ky.

MARYLAND — 3rd Fri., except April

CHAIRMAN—VAN RENSSELAER P. SAXE, 100 W. Monument St., Baltimore, Md.

SECRETARY-TREAS.—DONALD A. DARR, B. & O. R.R., B. & O. Central Bldg., Rm. 609, Baltimore, Md.

MILWAUKEE — 3rd Fri.

CHAIRMAN—E. C. BREKELBAUM, Harnischfeger Corp., Milwaukee, Wis.

SECRETARY—GILBERT F. MEYER, Machinery & Welder Corp., Milwaukee, Wis.

MOBILE

CHAIRMAN—REYNOLD ALONZO, Rt. 3, Box 24, Stanton Rd., Mobile, Ala.

SECRETARY-TREAS.—W. E. KELLY, 1561 Luling St., Mobile, Ala.

NEW JERSEY — 3rd Tues.

CHAIRMAN—R. E. POWELL, Western Electric Co., 100 Central Ave., Kearny, N. J.

SECRETARY—F. G. FLOCKE, 938 Woodmere Drive, Westfield, N. J.

NEW YORK — 2nd Mon.

CHAISMAN—G. V. SLOTTMAN, Air Reduction Sales Co., 60 East 42nd St., New York 17, N. Y.

SECRETARY—GEORGE SYKES, The Linde Air Products Co., General Publicity Dept., 30 E. 42nd St., New York, N. Y.

NORTHWEST — 3rd Wed.

CHAIRMAN—JOHN MIKULAK, Electric Machinery Mfg. Co., 1331 Tyler St., N. E., Minneapolis, Minn.

SECRETARY—ALEXIS CASWELL, Manufacturers' Assoc. of Minn., 200 Builders Exchange Bldg., Minneapolis, Minn.

NORTHERN NEW YORK — Last Thurs.

CHAIRMAN—E. R. SPITTLER, 6 Cornelius Ave., Schenectady, N. Y.

SECRETARY—R. S. PELTON, General Electric Co., Schenectady, N. Y.

OKLAHOMA CITY — First Thurs.

CHAIRMAN—M. G. WICKER, Air Reduction Sales Co., Oklahoma City, Okla.

SECRETARY—J. W. BLAKE, Oklahoma Gas & Elec. Co., 3rd & Harvey Sts., Oklahoma City, Okla.

PEORIA—CENTRAL ILLINOIS — 3rd Wed.

CHAIRMAN—WALTER J. BROOKING, R. G. Le Tourneau, Inc., Peoria, Ill.

SECRETARY—HAROLD BALDWIN, R. G. Le Tourneau, Inc., Peoria, Ill.

PHILADELPHIA — 3rd Mon.

CHAIRMAN—G. R. JOHNSON, The Lincoln Electric Co., 401 N. Broad St., Philadelphia 8, Pa.

SECRETARY—K. W. OSTROM, 213 Glen Gary Dr., Westgate Hills, Upper Darby P.O., Pa.

PITTSBURGH — Middle Wed.

CHAIRMAN—C. H. JENNINGS, Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

SECRETARY—J. F. MINNOTTE, Minnotte Bros. Co., 1201 House Bldg., Hays (7) Pittsburgh, Pa.

PUGET SOUND — Last Thurs.

CHAIRMAN—M. Q. CELLERS, Rt. 3, Box 556, Seattle, Wash.

SECRETARY-TREAS.—G. L. TAPLEY, Webster Welding Co., 1211 Pine St., Seattle, Wash.

ROCHESTER, N. Y. — 1st Thurs.

CHAIRMAN—EVERETT L. HAND, Gleason Works 1000 University Ave., Rochester, N. Y.

SECRETARY—HAROLD J. KING, University of Rochester, Engineering Dept., Rochester 3, N. Y.

SAN FRANCISCO — Last Fri.

CHAIRMAN—ROBERT O. WALDMAN, Chicago Steel & Wire Co., 1043 Bryant St., San Francisco, Calif.

SECRETARY—R. E. LABAGH, Victor Equipment Co., 844 Folsom St., San Francisco, Calif.

ST. LOUIS — 2nd Fri.

CHAIRMAN—E. F. MEIER, 2603 Louis Ave. Brentwood, Mo.

SECRETARY—H. C. CLOSE, Machinery & Welder Corp., 700 S. Spring Ave., St. Louis, Mo.

SAVANNAH

CHAIRMAN—L. W. ROBERTS, Little Burnside Island, Vernon View, Savannah, Ga.

SECRETARY-TREAS.—F. M. GILBERT, Southeastern Shipbuilding Corp., Savannah, Ga.

SOUTH TEXAS — 3rd Thurs.

CHAIRMAN—W. T. HUDSON, Chicago Bridge & Iron Co., Box 2567, Houston, Texas

SECRETARY-TREAS.—A. E. WISLER, Hughes Tool Company, 300 Hughes St., Houston, Texas

SYRACUSE — 2nd Thurs.

CHAIRMAN—J. KIELB, Easy Washing Machine Co., Syracuse, N. Y.

SECRETARY—J. HOTCHKISS, Bentley Welding, Inc., Syracuse, N. Y.

TOLEDO

CHAIRMAN—JOHN C. GEISLAND, City Auto Stamping Co.,Lint & Dura Sts., Toledo 12, Ohio

SECRETARY—EDWIN NAPZGER, Toledo Steel Tube Co., 2105 Smead Ave., Toledo 6, Ohio

TULSA, OKLA.

SECRETARY—JAMES B. DAVIS, Tulsa Testing Labs., Tulsa, Okla.

WASHINGTON, D. C. — 2nd Tues.

CHAIRMAN—H. L. INGRAM, JR., Air Reduction Sales Co., 1823 L St., N. W., Washington, D. C.

SECRETARY—G. G. LUTHER, Naval Research Lab., Anacostia Station, Washington, D. C.

WESTERN MASSACHUSETTS — Last Mon.

CHAIRMAN—WILLARD A. EMERY, Worthington Pump & Machinery Co., Holyoke, Mass.

WESTERN MICHIGAN

CHAIRMAN—C. LANPHEAR, C. H. DUTTON Co., 630 Gibson St., Kalamazoo, Mich.

SECRETARY—R. D. LAYMAN, The Lincoln Electric Co., 200 Division Ave., Grand Rapids 2, Mich.

WESTERN NEW YORK — 3rd Fri.

CHAIRMAN—JOSEPH COUSINS, J. D. Cousins & Sons Boiler Wks., 667 Tifft St., Buffalo, New York

SECRETARY—R. S. LANE, Ross Heater & Mfg. Co., 1407 West Ave., Buffalo, N. Y.

WICHITA, KAN. — 2nd Wed.

CHAIRMAN—M. A. BARRETT, Beech Aircraft, Inc., Wichita 1, Kans.

SECRETARY—DON SCHWARTZ, Air Reduction Sales Co., 402 E. 29th St., Wichita, Kan.

YORK—CENTRAL PA. — 2nd Wed.

CHAIRMAN—E. E. ROUSCHER, A. B. Farquhar Co., York, Pa.

SECRETARY—C. E. LEWIS KERCHNER, R. D. No. 1, Thomasville, Pa.

YOUNGSTOWN, OHIO — 2nd Mon.

CHAIRMAN—ROBERT FISHER, 1534 Thomas Road, Warren, Ohio

SECRETARY—CARL J. HELTZEL, Hetzel Steel Form & Iron Co., Warren, Ohio

THE AMERICAN WELDING SOCIETY

ACTIVITIES – RELATED EVENTS

EXECUTIVE COMMITTEE MEETING

The meeting of the Executive Committee, A.W.S., was held in Room 1105, A.S.M.E. Headquarters, Engineering Societies Bldg., New York City, on March 15, 1944. The meeting was called to order by President Arnott at 10:15 A.M., with the following members present: C. A. Adams, H. C. Boardman, R. W. Clark, O. B. J. Fraser, I. Harter, and A. C. Weigel. Others present were H. O. Hill, Vice-Chairman, Outline of Work Committee, W. Spraragen and M. M. Kelly.

Relationship of W.R.C. to the A.W.S. and Its Standardization Committees

The President made reference to the document prepared by the Secretary of the W.R.C. covering the historical background and present organization of the Council, its relationship to National Defense Research Committee and its tie-in with the A.W.S. Copy of this was submitted to members of the Executive Committee in advance of this meeting and is attached to the minutes of the meeting sent to the Board of Directors.*

In the discussion the following points were brought out.

1. There is need for a greater understanding of the relationship of W.R.C. and A.W.S.
2. The A.W.S. Technical Committees ought to pay more attention to the coordination of activities of the W.R.C. and A.W.S. Technical Activities.
3. The objective of the SOCIETY is and always has been to service industry.
4. A large portion of the money contributed for research is earmarked for specific projects and is unavailable for researches that might be referred to the Council by A.W.S. Technical Committees.
5. Affiliation of W.R.C. with Engineering Foundation facilitates contributions to research, and cooperating engineering Societies are each encouraged to look upon W.R.C. as their welding research organization.
6. Through ninety or more common members of W.R.C. project committees with A.W.S. Technical Committees, needed research is carried out by W.R.C. and results utilized by A.W.S. Technical Committees.
7. Good use is being made of research work conducted under W.R.C. in the technical activities of the SOCIETY, not only in the drawing up of standards and codes but also in the SOCIETY'S publications and in its Annual Meeting programs.

It was voted that a Research Coordinating Committee under the Outline of Work Committee be appointed; further, that the Outline of Work Committee be requested to submit scope and personnel for such committee; and, further, that when such committee is appointed, the Executive Committee of A.W.S. request the Welding Research Council to accept that committee as the A.W.S. Advisory Committee to W.R.C.

Appointments

The following appointments, made since the last Executive Committee meeting, were confirmed:

Additions to A.W.S. Committees.—Publicity: R. S. Donald, Thomson-Gibb Electric Welding Co. *Convention:* M. L. Smith, Metal & Thermit Corp., representing the Publicity Committee.

NOTE! The above appointments were made on recommendation of the Publicity Committee.

A.W.S. Representative at Sessions of Other Technical Groups.—Building Officials of America Conference in Rochester, February 14—Purpose: to discuss postwar program on building codes—T. R. Higgins, Chairman, A.W.S. Committee on Building Code, S. A. Greenberg, Acting Technical Secretary, A.W.S.

Investigation and Testing at Fort Belvoir Under Auspices of War Department Engineer Board—Purpose: to develop welding procedure for field splicing of large steel beams—LaMotte Grover was selected because of his interest in structural design.

A.S.M.E. Boiler Code Committee Hearing, March 8th, on Revision Paragraph P-112(e): C. W. Obert, with W. D. Halsey as alternate.

NOTE! Above appointments were made on recommendation of Outline of Work Committee Chairman.

Proposal for Changes in A.W.S. Committee Personnel.—Appointment of Metallizing Standards Committee: It was voted to approve recommendation of Outline of Work Committee for the appointment of a Metallizing Standards Committee, with the following scope and personnel:

Scope: This committee should establish standards for design data, manufacturing practices and inspection methods which are essential for the various fields of application. It should also cover such standards as definitions, symbols, test methods and other such standards as are required by industry.

Personnel: Air Reduction Co.; AMERICAN WELDING SOCIETY, S. A. Greenberg, Secretary; Bell Telephone Laboratories, W. G. Knox; Bethlehem Shipbuilding, T. Hughes; Bureau of Ships, Navy Dept.; General Electric Co.; Metallizing Co. of America; Metallizing Engineering Co., D. C. Boltz; Metalweld Co., H. S. Hammond; Standard Oil Co. of N. J., M. F. Sheeley; Westinghouse Elec. & Mfg. Co., N. L. Mochel. In connection with personnel, it is to be noted that the proposed membership is quite representative of industry and was intentionally kept small in order to permit the committee to get started on outline of program. As interest develops, the membership can be expanded and subcommittees formed. In certain cases, individuals have been named rather than organizations because it was felt that they could logically represent the interest.

National Research Council, Engineering Division: It was voted that the following names be suggested to the Chairman of the Engineering Division of N.R.C. as possible candidates for the appointment on the Engineering Division of N.R.C.: H. C. Boardman, J. H. Critchett, W. Spraragen.

Proposed Program for Publicizing Activities of A.W.S. and Its Sections

It was recalled by the President that at the Directors' meeting in Chicago on October 21, 1943, a small Publicity Committee was appointed whose first duty was to consider and offer recommendations on publicity policies and program for the approval of the Board of Directors. Mr. C. J. McDonough, public relations man in Combustion Engineering Co., and Past-President of National Advertisers Association, agreed to serve temporarily as Chairman of this Committee. The findings of this Committee were reported by Mr. McDonough, under date of February 29th. The report embodies definite recommendations and suggested publicity program.

It was the consensus of opinion that the proposed program of publicity is logical and the Committee under the Chairmanship of Mr. McDonough should be commended for the time and effort the report represents.

It was voted to adopt publicity program recommended by the Publicity Committee; further, to accept the Committee's recommendation for the employment of Mr. J. L. Stover (Associate Editor of Simmons-Boardman Publishing Co.) on a part-time basis.

Welding Handbook

In view of 1943 sales, the fact that as of December 1, 1943, stock was depleted to 2339 copies of the book, it was voted to authorize the Welding Handbook Committee to proceed with reprinting of 5000 copies of the 1942 edition of the *Welding Handbook*.

* Reproduced elsewhere in this issue.

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BELL TELEPHONE SYSTEM

Royalty Payments to Authors of Educational Books Published by A.W.S.

It was voted to accept the following recommendations on payment of royalties to authors of educational books:

1. Books covering researches paid for by the SOCIETY or W.R.C. or prepared by more than three authors shall not be subject to royalties.
2. No author or authors may receive royalties for more than a five-year period unless the book represents a new edition, in which case a new edition shall be treated as a new book.
3. If sufficient revenue has been derived to pay all costs of a book, royalties shall be paid to an author or authors from any balance remaining, in an amount up to but not exceeding 10% of total gross receipts for the book. Payment shall be made once a year.

Heating, Piping and Air Conditioning Contractors National Association

The President made reference to an invitation received by the A.W.S. from the subject association to appoint a representative on its Editorial Committee that will undertake the revision of the *Standard Manual on Pipe Welding*. In this letter, it was pointed out that the A.W.S. and other organizations were invited to participate in this activity because of their interest in pipe welding and the desire of the H.P.&A.C.C.N.A. to make the *Standard Manual on Pipe Welding* of the greatest possible use to industry. Representatives of the contracting field, the manufacturing field, insurance and governmental agencies are being invited to participate in the revision of the manual.

After consideration, it was voted to accept invitation of H.P.&A.C.C.N A. for the appointment of a representative on its Editorial Committee for the revision of the *Standard Manual on Pipe Welding* and to designate, subject to the approval of the A.W.S. Outline of Work Committee, Mr. D. H. Corey as A.W.S. representative.

1944 Annual Meeting

Result of letter ballot vote indicating the wishes of the Board of Directors on length and type of Annual Meeting was reported as follows:

20 Directors favored a $3^1/_2$-day meeting.
1 Director favored a 5-day meeting.
3 Directors did not reply.
18 Directors favored a $3^1/_2$-day meeting without social activities.
2 Directors favored a $3^1/_2$-day meeting with social activities.

It was reported that the Convention and Program Committees are proceeding with plans for a $3^1/_2$-day meeting with no social activities.

RESEARCH PROBLEMS

Probably one of the most useful services that the Welding Research Council's committees render is to stimulate welding research in the different universities of this country. In this way we are able to solve current research problems and as a by-product we are able to train young men in the welding research field.

This work comes under the direction of our University Research Committee. As one of its endeavors the committee is compiling a list of current needed research problems, and in this capacity is asking the cooperation of the entire welding industry to suggest problems needing solution. The problems may be listed by title or formulated in considerable detail.

An early response is respectfully requested.

SUSTAINING COMPANY

Graver Tank & Mfg. Co., Inc., was founded in 1862. The present Graver organization, with its main plant at East Chicago, Indiana, and plants at Catasauqua, Pennsylvania, and Tulsa, Oklahoma, has kept pace with latest developments and are ideally equipped to fabricate all types of shop built and field erected steel plate equipment. Pressure vessels, storage tanks, weldments, water softeners and filters, sugar clarifiers, sewage treatment equipment—all are among the many types of equipment being currently built by Graver plants and are indicative of the scope of Graver activities in serving many diversified fields.

SUSTAINING COMPANY

L. O. Koven & Brother, Inc., 154 Ogden Ave., Jersey City 7, N. J., specializes in the fabrication of metal tanks and industrial or marine equipment involving rigid

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For

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. . . Created to disseminate factual information and knowledge gained from the experience of successful users of EUTECTIC *Low Temperature* Welding, the new welding process which is gaining wide acceptance in production, salvage and maintenance. All metals from aluminum to zinc die-castings can be joined by this process. Applicable with oxy-acetylene torch, metallic-arc, induction and furnace heating.

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Welders, welding engineers, and metallurgists have acclaimed the arrival of The EUTECTIC WELDER. An engineer writes:

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requirements. Now producing intricate fabricated metal parts for war.

Organization dates back to 1881. Complete engineering service from consultation through development and actual production. Operates two large plants at Dover and Jersey City. These plants are equipped with the latest types of machinery for fabricating, welding, X-ray, stress relieving, sandblasting, machining and galvanizing.

SUSTAINING MEMBERS

Gulf Shipbuilding Corporation, Chickasaw, Alabama. Building vessels for the U. S. Navy, C2-S-E1 vessels for the U. S. Maritime Commission, and large, high-speed, twin-screw refrigerated vessels for the United Mail Steamship Company.

The yard is located on Chickasaw Creek, about six miles north of Mobile, Alabama. The yard has 8 building ways.

The J. E. Haseltine & Co. of Portland, Ore., originated 62 years ago. It has been active in the welding supplies for the last 16 years. Besides handling a complete line of welding supplies, they also carry a complete line of industry and shop supplies.

They are distributors for General Electric electrodes and machines, Hollup, Arcos, Eureka, Stoody, Handy & Harman, and many other brands of electrodes. They also distribute Victor acetylene equipment and Jackson products. Office and stock located in Portland, Tacoma and Seattle.

National Board of Boiler and Pressure Vessel Inspectors, 145 North High St., Columbus, Ohio. A national organization of the Chief Boiler Inspectors of the states, cities and other governmental jurisdictions that have adopted and enforce any of the Codes of The American Society of Mechanical Engineers. The purpose of the organization is to promote uniform boiler laws and rules, to secure uniform approval of specific designs of boilers, pressure vessels and appurtenances and to promote one uniform code of rules and accompanying stamping.

WIRE ASSOCIATION MEETING

At the annual meeting of the Board of Directors of the Wire Association held at the Waldorf-Astoria Hotel, New York, on March 24th the following officers were elected for the ensuing year:

President, D. D. Buchanan, Manager of Operations, Union Drawn Steel Division, Republic Steel Corp., Massillon, Ohio; *Vice-President*, R. M. Hussey, Supt. Wire Dept., Jones & Laughlin Steel Corp., Aliquippa, Pa.; *Vice-President, Non-ferrous Division*, E. W. Gundstrom, Asst. Plant Manager, Rome Cable Co., Rome, N. Y.; *Executive Secretary*, R. E. Brown, Publisher, Wire & Wire Products, 300 Main St., Stamford, Conn.

New directors seated at the meeting were: Kenneth H. Davis, President, K. H. Davis Wire & Cable Co., Los Angeles, Calif.; and Flint C. Elder, Special Research Engr., American Steel and Wire Co., Cleveland, Ohio.

The general chairman for the Program Committee for the 1944 Convention will be Mr. Gundstrom and the chairman of the Non-ferrous Division Program Committee, Mr. C. A. Litzler, Chief Engr., Industrial Oven Engineering Co. of Cleveland, Ohio. It was voted to hold the Annual Convention at Cleveland, Ohio, in association with the American Society for Metals as in previous years.

The directors' meeting was followed by a luncheon with over 50 in attendance and an interesting "Navy Industrial Incentive" Program was presented under the direction of Lt. Commander J. D. Gessford, U.S.N.R. The meeting closed with a Navy motion picture, "Battle for the Beaches."

SMALLER WAR PLANTS CORPORATION WASHINGTON, D. C.

Information Regarding Foreign-Owned U. S. Patents Available to Manufacturers through Technical Advisory Service, Smaller War Plants Corporation

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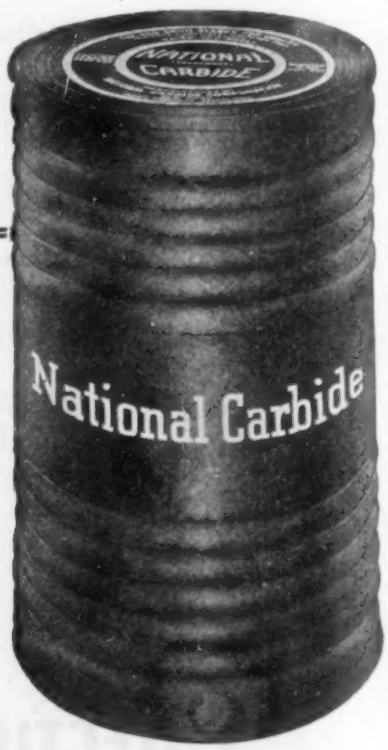

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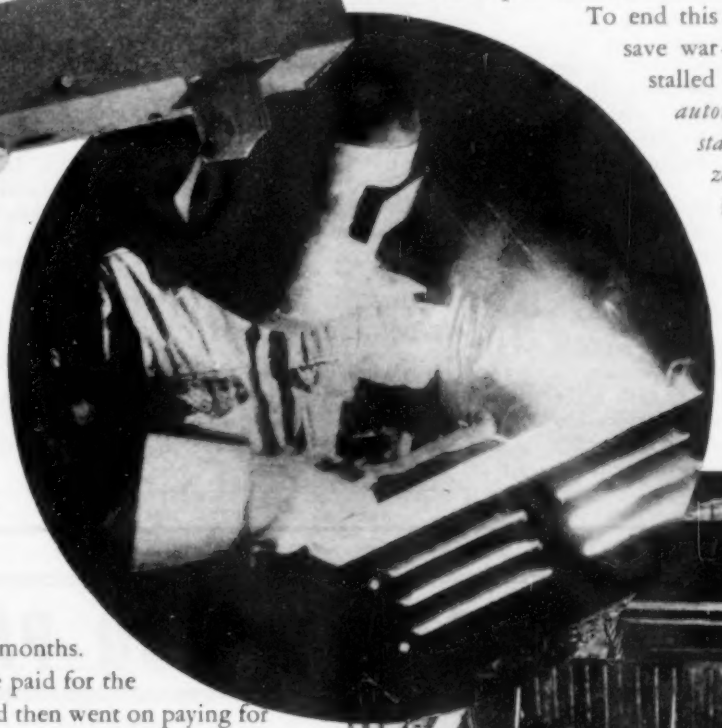
Are YOU Paying for Your Welding Machines TWICE?

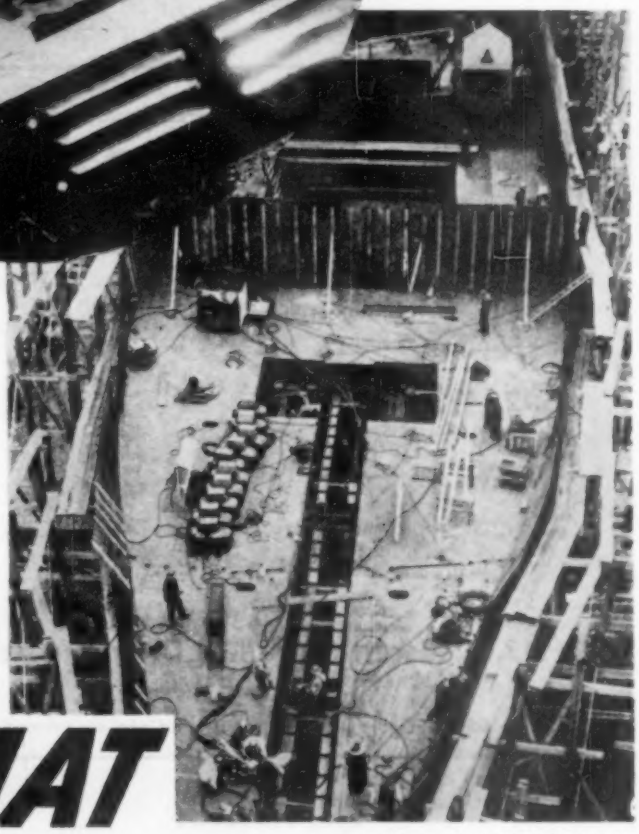


The hp model 1010 Automatic Welding Machine Starter with Arc-time Totalizer is designed to operate in conjunction with any standard welding motor-generator set. It starts the welding machine when the welder touches the rod to the work. After a short interval of no welding, the control automatically stops the machine. Whenever welding is in progress, arc-time is counted by a synchronous totalizer. The totalizer does not operate when the rod is shorted to the work, thus only actual arc-time is recorded.

Welding engineers in a leading U. S. shipyard discovered that the power wasted when their machines were actually "idling," was actually piling up such a large total that the company was paying for its welding machines twice. Careful records showed that the idle welding machine time was 75% of the 21-hour welding day—that the total power waste added up to 31.7% of the total power used.

To end this needless expense, and save war-time power, they installed *-hp-* Arc-o-Mats . . . *the automatic welding machine starter with arc-time totalizer* . . . on over 500 welding machines.

Their published report shows the power savings—and other benefits—achieved in the next few months. It shows how power savings alone paid for the *-hp-* controls in 6 to 7 months, and then went on paying for the welding machines with money the company DIDN'T get. It also shows other economies and increased production which resulted from the *-hp-* Arc-o-Mat Totalizer attachment. In addition, it shows the large savings which grow from the fact that, with the *-hp-* Arc-o-Mat, the *same facilities can serve many additional welding machines.*



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If your welding machines are working without automatic controls, you are due for a shock when you apply this report to your own welding costs. You too, can end this waste. Just write us for the "Shipyard Waste-Power Report." You incur no obligation. Write today, NOW.

ARC-O-MAT

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foreign inventions—and for only a nominal charge? There are approximately 45,000 patents and pending patent applications which were formerly owned by residents of enemy and enemy-occupied countries but which have now been seized by the Alien Property Custodian. All except those patents already exclusively licensed to American firms prior to their seizure are available for use by any American manufacturer on a nonexclusive basis. The enemy patents will not be returned to their former owners after the war and are now being licensed on a royalty-free basis for the life of the patent. The only charge is an administrative fee of $15 for each patent licensed.

These patents are the result of millions of man-hours of the finest research and include inventions by leading foreign scientists and technicians in nearly every field of applied science. They include many new inventions and ideas for new products which your plant may find useful. Or, you may find something suitable for reconverting your facilities to manufacture some other useful product.

You can receive full information about the simple licensing procedure governing the use of these patents from the Smaller War Plants Corporation by following one of these steps:

1. By contacting your nearest regional Technical Advisory Service, a new service set up in each of 14 Smaller War Plants Corporation regional offices to assist you in the solution of your technical problems.
2. By contacting your nearest district office manager, who is acquainted with this program and can properly direct you to the point to get the information you desire.
3. By visiting your regional Technical Advisory Service office or one of the district offices, where a classified list of all the alien patents is located which shows the number of patents under each classification and a short description of each one.

NATIONAL CHEMICAL SHOW IN CHICAGO COLISEUM NOV. 15-19

Sponsored by the Chicago Section of the American Chemical Society, the third National Chemical Exposition will be held Nov. 15 through 19, 1944, at the Chicago Coliseum, it is announced by M. H. Arveson, Chairman of the Exposition Committee.

Headquarters for the show have been opened at 330 South Wells Street, Chicago 6, Ill.

WELDING FUTURE BOX CARS

Welding, the ancient industrial process that has emerged as an essential construction method in war production, will be used extensively after the war to build lightweight box cars that will save up to 20% in weight and increase payloads correspondingly, Wallace N. Barker, vice-president of Pullman-Standard Car Manufacturing Co., predicted today.

"In the welding which we will do in the postwar period we will make use of our experience in manufacturing war products for the Army and Navy, just as, when getting into war work, we drew upon our peacetime know-how in making welded railway equipment," he said in a statement issued in connection with the publication of a special March welding issue of the company magazine, *The Carbuilder*.

"Confronted with the problem of creating war weapons of exceptional ruggedness with a minimum of dead weight, Army and Navy ordnance designers specified welding as an essential part of the construction. These products take far more abuse on the battlefield and in naval combat than railway cars ever do in normal operation, yet they have demonstrated that they can 'take it.'"

It will take many years to replace the railroads' 1,700,000 over-age heavyweight freight cars but such a program is expected to begin immediately on the arrival of peace, Barker stated.

A. O. SMITH WELDING EQUIPMENT DISTRIBUTOR

The A. O. Smith Corp., Milwaukee, Wis., announces the appointment of Pacific Metals Co., Ltd., as distributor

INTRODUCTORY $10.00 PACKAGE

Contents
Manganal Special Tite-Kote
Welding Electrodes
5 lbs. 1/4" x 18"
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For welding of 11 to 14% Manganese Steel

Gyratory, Roll, Jaw Crushers, Dipper Teeth, Pump Shells, Impellers and all Equipment that wears due to impact and abrasion.

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"MAJOR" WELDING CABLE is sold through hundreds of appointed dealers. Our certified dealers are qualified to quote lowest prices and offer prompt shipments. In most cases you will be able to order *"MAJOR"* WELDING CABLE by a local telephone call.

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Offices and Agents all over the United States

in California, Nevada and Arizona for SMITHway Certified Electrodes, A.-C. Welders and other welding equipment. Substantial stocks of these nationally recognized products will be carried in Pacific Metals' warehouses at 3100 Nineteenth St., San Francisco, and at 1400 South Alameda St. Los Angeles.

ARC-WELDING TOOL AND DIE STEELS

A handbook of engineering data, welding procedures and heat treatment procedures for tool and die steels has been published by C. E. Phillips and Co., 2750 Poplar St., Detroit 8, Mich., under the title, *Arc Welding in the Maintenance and Construction of Tools and Dies.* In the introduction, it is pointed out that the successful use of arc welding on forming, stamping, forging and blanking dies depends on the selection of electrode material which will yield a deposit possessing physical properties comparable to those of the parent metal, and also qualities which respond to the same heat treatment as prescribed for the parent metal. That is, the more that is known about the parent metal, the better the conditions are for a wholly satisfactory application. Ten types of electrodes are described in following pages, each of these types being designed for a certain range of group of steels. The text explains the range of application of each electrode and furnishes heat-treatment data, deposit characteristics, physical properties and special details of application procedure. Photomicrographs show grain structures in the as-welded and the heat-treated conditions, and tempering curves indicate the hardness ranges obtainable by heat treatment. Illustrations of typical applications suggest that there is a considerable field of usefulness for this process not only in repair and salvage but also in the composite construction of new tools and dies, employing a less expensive steel for the body and depositing only enough of the special steel to provide a working surface or edge.

TOOL STEELS

Tool Steels, by J. P. Gill, Vice-President and Chief Metallurgist, Vanadium-Alloys Steel Co., and R. S. Rose, G. A. Roberts, H. G. Johnstin, R. B. Geoge, Metallurgical Staff, Vanadium-Alloys Steel Co.

The purpose of this book has been to present as concisely as possible both the theoretical and practical information that exists on the more commonly used types of tool steel. The book has been written mainly for those who use tool steels and it is hoped that the data included will be of material help to them in becoming better acquainted with the many types of tool steels produced and in solving tool problems. The sections on Manufacturing, Testing and on the Principles of Heat Treatment may prove somewhat elementary and have been included to establish a sound background for the more technical points and to enable the reader to properly evaluate the data presented elsewhere in the text.

Published by American Society for Metals, Cleveland, Ohio. 577 pages. Price $6.00.

VICTOR EQUIPMENT COMPANY

An unusually interesting booklet has been prepared by the Victor Equipment Company, 844 Folsom St., San Francisco 7, Calif., for the purpose of telling the company's stockholders, customers and co-workers a little more about Victor.

CURRENT-REGULATING COMPENSATOR

The General Electric Co., Schenectady, N. Y., has issued a technical bulletin GEA-4207, describing their Current-Regulating Compensator for G-E Thyratron-Welding Control. Copy available on request.

LOCATING SPOTWELDING OR RIVETING WORK

An interesting pamphlet (No. 203-A) has been published by Sciaky Bros., 4915 West 67th St., Chicago, Ill., describing the Sciaky Locating Spotlight. This item has proved very useful on a wide range of production machinery.

A CORNER OF THE EISLER SPOT WELDER TEST DEPARTMENT

WE MANUFACTURE A COMPLETE LINE OF RESISTANCE WELDERS FROM ¼ TO 500 KVA, ARC WELDERS AND TRANSFORMERS OF ALL TYPES.—THERE IS AN **EISLER WELDER** FOR EVERY PURPOSE.

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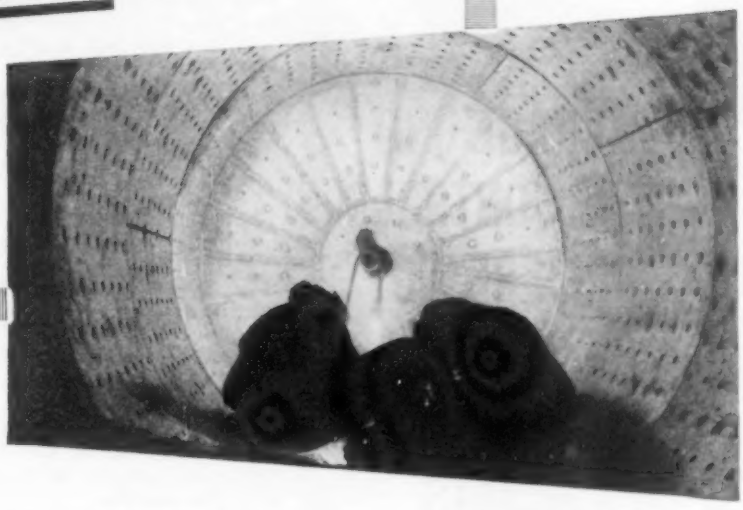
Here's How to
WELD IN LASTING LININGS
to stand the attack of severe corrosion!



Stepping up the service life of process tanks and vessels is vital in today's war production and equally important in plans for the post war period.

This may often be readily done by welding linings of sturdy, corrosion-resisting metals or alloys into vessels of steel, wood or concrete.

Monel*, Nickel* and Inconel* in sheet form are formed easily to all types of vessel contours. Sheets are punched for plug welding, and are also readily welded to themselves or to the steel vessel by the electric arc process.

In fact, electric arc welding is the only process recommended for the attachment of separate linings to steel equipment.

The minimum recommended sheet thickness for welded-in linings using Monel, Nickel or Inconel set by practical fabricating considerations is .062 in. (16 ga. U.S.S.). Usually, all welds are left in the as-welded or reinforced condition.

In lining existing equipment, sheets are employed as large as can be handled conveniently, or, if the vessel be closed, that can be put through a manhole or other opening.

In storage tanks 7 ft. or 8 ft. in diameter and smaller, in which fluctuations in pressure (breathing) are not to be encountered, the long dimension of each sheet may be disposed either longitudinally or circumferentially. Attachment to the steel by intermittent welds at sheet edges is sufficient, but lapped welds in the lining sheets obviously should be continuous. Because of the mild mechanical requirements of service, plug welds are not necessary.

Lining with narrow strips may be used in special cases where large sheets are impractical. Plug welding is omitted because strips are relatively small, from 3 in. to 12 in. wide and up to 4 ft. in length. Again .062 in. sheet or heavier is recommended.

Linings in Wood Tanks. In lining wood tanks with sheet metal, joints can be made either by soft soldering or silver brazing in the case of lighter gauges, .050 to .037 in. or thinner, or by electric arc welding in .050 or .062 in. sheet. For arc welding, a butt strap, to prevent burning of the wood and to anchor the lining of the tank, is placed behind each seam and it usually is screwed to the wood. If necessary, the lining itself can be screwed to the wood with Monel screws on 8, 12 or 24 in. centers according to requirements. The heads of the screws should be covered with soft solder or preferably silver brazing alloy to insure liquid tightness.

For new Metal Tanks of welded construction, the clad steels—Nickel clad, Monel clad, and Inconel clad—are recommended and are a highly satisfactory answer.

For further information write for Bulletin T-2 "Welding, Brazing and Soft Soldering of Monel, Nickel and Inconel." Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street **New York 5, N. Y.**

* Subject to Government priority regulations.

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Sheet...Strip...Rod...Tubing...Wire...Castings

electronic Weltronic bulletins

"PACKAGE UNIT" HEAT CONTROLS REQUIRE NO CHANGES IN WELDING CIRCUITS

Close current regulation in virtually any type of resistance welding installation can now be obtained by the simple addition of a Weltronic "package unit" heat control.

These controls are now available in three types: the 50Y single dial type where only one adjustment is required for one or more welds; the 50W with multiple dials for individual adjustments or for adjusting individual pulsation values; the 50XX providing adjustable automatic heat rise from preset minimum to preset maximum.

Write for Bulletin No. 50

Weltronic COMPANY

DETROIT 19, MICH.

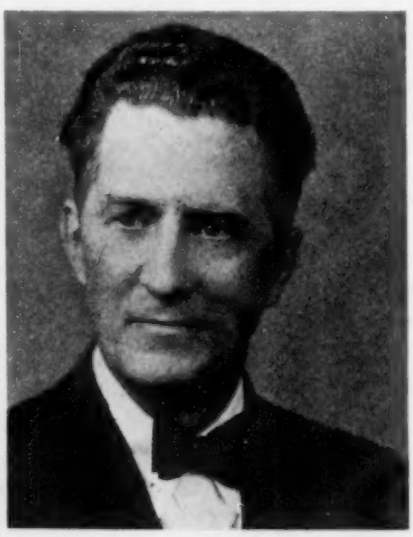
SPOT WELDERS

Manual and automatic spot welders made by Pier Equipment Mfg. Co., Benton Harbor, Mich., are illustrated and described in their recently published Catalog 42. Details of important parts, regulator controls and automatic weld timer for controlling the timing periods are given. The foot-operated welders listed range from 5 to 50 kva. capacity; the air-operated press types include 20 to 30 kva. capacities, with high-speed projection and spot welders of 30, 50, 75, 100 and 150 kva. capacities. Welding capacity charts for all welder sizes and for different throat depths are included.

BATTELLE TECHNICAL ADVISER TO GIVE HONORARY LECTURES

Dr. Samuel L. Hoyt, technical adviser, Battelle Institute, Columbus, Ohio, has been selected by the Golden Gate Chapter of the American Society for Metals to present its 1944 Educational Lectures. The lectures, on the subject, "Properties, Selection, and Specification of Alloys," will be delivered at the University of California, Berkeley, on April 19th, 20th 21st, 24th and 25th.

Each year the Golden Gate Chapter of the A.S.M. sponsors the series of five educational lectures on metals. The lecturer is selected from the foremost metallurgists of the country, and the privilege of giving the lectures constitutes a recognition of the lecturer's contributions to metallurgy. Previous lecturers have been M. A. Grossman, Director of Research, the Carnegie-Illinois Steel Corp.; E. C. Bain, Vice-President, the Carnegie-Illinois Steel Corp.; and V. N. Krivobok.



Dr. Samuel L. Hoyt

Dr. Hoyt, who is the author of many technical papers and several books on metallurgy, has been connected with the metals field for more than thirty years. A graduate of the University of Minnesota, he had advanced study at the Charlottenburg Technical School, Berlin, Germany, and at Columbia University, receiving his doctorate from the latter school in 1914.

From 1913 to 1919, he was assistant and associate professor of metallography at the University of Minnesota, and from 1919 to 1930 was a research metallurgist with the General Electric Co. In 1931 he became associated with the A. O. Smith Corp. and later became director of metallurgical research of that corporation. He joined the staff of Battelle Institute as technical adviser in 1939.

Dr. Hoyt is a member of the American Society for Metals, the American Institute of Mining and Metallurgical Engineers, the American Society for Testing Materials, the AMERICAN WELDING SOCIETY, Sigma Xi and the Institute of Metals (England). He has been active in the Schenectady and Milwaukee Chapters and the National Office of the A.S.M. and has been on various committees of the A.I.M.E., including those of the Institute of Metals Division and the Iron and Steel Division. He was the A.I.M.E. Institute of Metals Lecturer in 1930, and the A.S.M. Campbell Memorial Institute Lecturer in 1940. He has served on the A.S.T.M. Committee on High Temperature Alloys, and is currently a member of the Welding Research Committee of the Engineering Foundation.

Dr. Hoyt is known particularly for his leadership in the development of cemented carbides for cutting tools and for his work on temperature-resistant alloys. At the A. O. Smith Corp., an important phase of his duties was to guide the metallurgical development of pressure vessels for the oil, chemical and related industries. At Battelle, in addition to acting as adviser on varied metallurgical research, he directs the Institute's program of welding research. One of his most recent works is the *Metals and Alloys Data Book*, which was published by the Reinhold Publishing Corporation last year.

AUSTIN PROMOTIONS

J. K. Gannett, vice-president of The Austin Company and its eastern district manager since 1928, has been appointed director of engineering, in charge of engineering and research, according to announcement by George A. Bryant, president.

A native of Wellington, Ohio, and a graduate of the University of Michigan

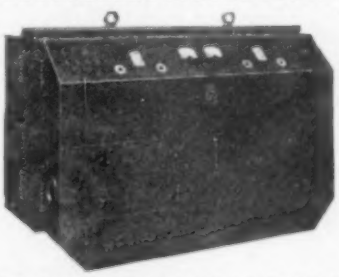
J. K. Gannett

EXPERIENCED HELP

READY, WILLING and ABLE to work for *You*

● G-R **MANUAL WELDERS** for maintenance, production and general shop use are available in eight standard models, ranging in capacity from the 10-100 ampere Model 10 to the 100-675 ampere Model 49 (sizes to 2,500 amperes included in the "Combination" classification, below). These modern a.c. units deliver a smooth, steady arc that handles easily in *all* welding positions; control is stepless and uniform, efficiency high. All units are available in "C" models, with Power Factor Correction and Class B insulation.

● G-R **AUTOMATIC WELDERS** provide a highly-efficient, accurately-controlled source of power for automatic and UNIONMELT welding heads. Now at work in the nation's leading shipyards and heavy fabrication plants, G-R units have established an excellent record for dependable, low-cost performance. Sizes range from the 400-1000 ampere Model 55 to the 500-2500 ampere Model 88. Power Factor Correction available for all models; Class B insulation is standard.



● G-R **COMBINATION WELDERS** are used for both manual and automatic welding. Wide current range, ease of control, and extremely high efficiency at any load make these ideal general-purpose machines for large shops where requirements vary widely. Capacities range from the 125-1250 ampere Model 65 to the 125-2500 ampere Model 85. Power Factor Correction available for all models; Class B insulation standard.

● G-R **VOLT-O-MATIC CONTROL** assures absolute safety, increases welding production. VOLT-O-MATIC Control can be used with any a.c. welder; it reduces no-load open circuit voltage to less than 10 volts (operators can change electrodes without a "sting" even when it's rainy and wet!). Arc time totalizer accurately records actual arc time... provides a continuous record of output for each welder. Shipyards and others now using VOLT-O-MATIC report production increases up to 20% from this "production control" feature!

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in civil engineering, Mr. Gannett joined The Austin Company as assistant chief engineer in the Cleveland district in 1915, following five years of experience as field engineer, draftsman and designer and supervising engineer for railroad, coal, steel fabricating and engineering companies.

He served as Paris manager for the company during and after World War I and was named New York district sales manager late in 1919, continuing in that post until he was named vice-president and district manager. He is a member of the American Society of Civil Engineers, the AMERICAN WELDING SOCIETY, the American Concrete Institute and the National Society of Professional Engineers.

The election of Albert S. Low, vice-president of the company, now in charge of its Washington office, and A. F. Plant, vice-president and Detroit district manager, as directors of The Austin Company was also announced. Mr. Plant is a member of the American Society of Civil Engineers, and Mr. Low a member of the AMERICAN WELDING SOCIETY, the Welding Research Council and a member of the American Concrete Institute.

Mr. Low, a graduate of the Sheffield Scientific School at Yale University joined the Austin organization as a construction superintendent in 1913 and has served as vice-president and chief engineer since 1934. He directed the company's overseas operations immediately prior to the outbreak of war in 1939, and after his return in 1940 was directly in charge of a number of major war projects,

Albert S. Low

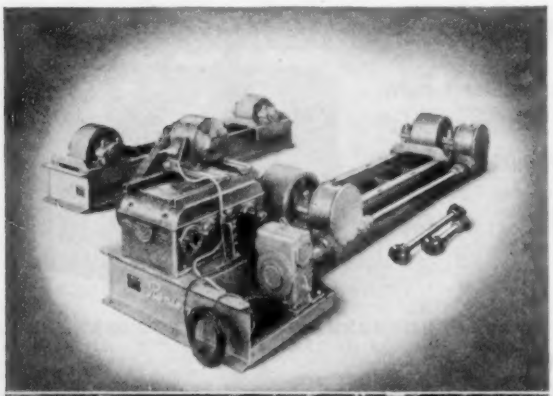
including engineering on the original units of the Dow Chemical Company's "magnesium-from-sea-water" facilities in Texas, and the design and construction of four of the country's largest aircraft factories.

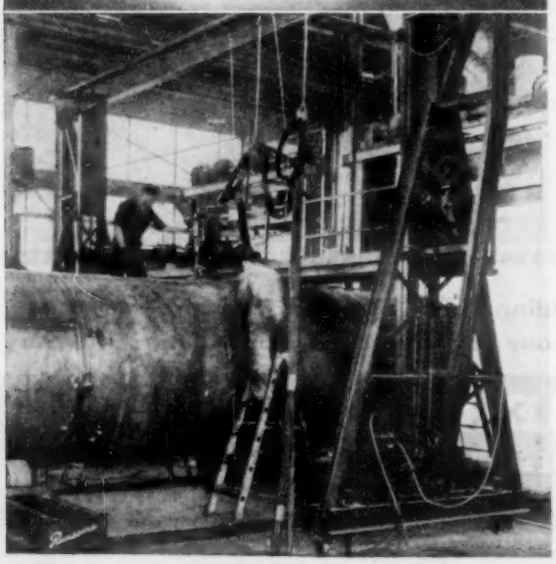
Mr. Plant is a civil engineering graduate of Ohio Northern University and joined the company in 1920 as a designer in the New York office. He has been manager of the Detroit district since 1927 and a vice-president of the company since 1938. He is also president of Austin Engineers, Inc., of Detroit.

WELDED SURPRISE PACKAGES FOR HITLER AND TOJO

The countless articles of war that are produced by arc welding includes virtually every kind and type of material, equipment and ordnance item for our armed forces, according to a recent review of arc

Two-Ton Blockbuster of Welding Design and Detail of Welded Seams in Bomb Structure
Nose of bomb points upward.





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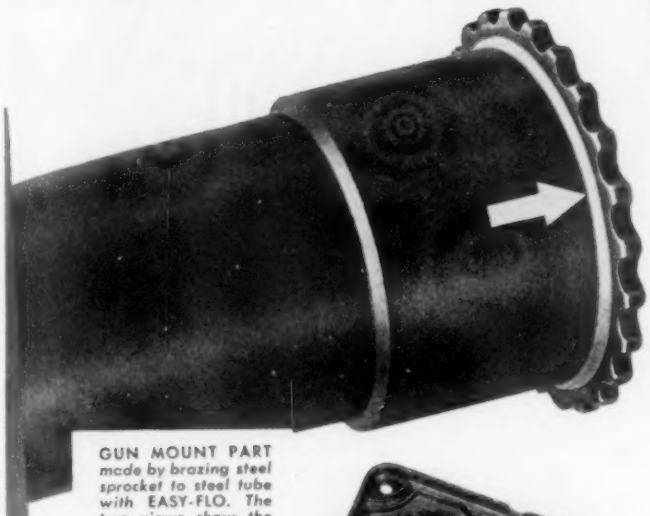
LABOR-METAL-COST-SAVING

EASY-FLO

BRAZED CONSTRUCTION

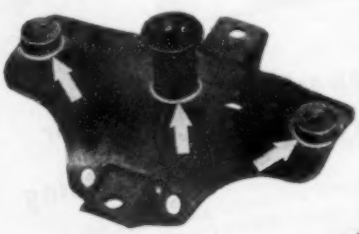


—in post-war manufacturing

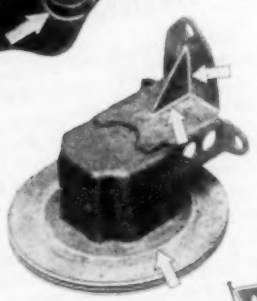
GUN MOUNT PART made by brazing steel sprocket to steel tube with EASY-FLO. The two views show the complete penetration which features EASY-FLO action.

Right: NAVY SWITCH BOX COVER made with EASY-FLO wire preplaced at 12 joints and brazing all 12 simultaneously by induction heating. Brazing time—3 minutes per cover.

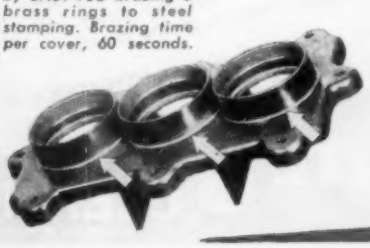
Left: Steel HANGER BRACKET for small motor used in aircraft formerly cast, now made of a stamping with parts EASY-FLO brazed.



Right: MARINE DECK FITTING formerly an aluminum casting, now made of steel stampings and brass rings brazed with EASY-FLO.



Below: NAVY GAUGE BOX COVER fabricated by EASY-FLO brazing 3 brass rings to steel stamping. Brazing time per cover, 60 seconds.



War production placed a premium on speed with reliability and on conservation of metals—which is exactly why EASY-FLO brazed construction has spread through industry in a swift running tide.

Scores of parts formerly cast, forged or turned from the solid have been redesigned for EASY-FLO brazed construction, and scores of new parts have been designed from scratch to get the benefit of the substantial savings in time, labor, metals and cost that go with EASY-FLO brazed construction. A few typical examples are illustrated.

It's the ability of the low-temperature, free-flowing silver alloy EASY-FLO to make remarkably strong joints, fast, reliably and at low cost that is responsible for the unqualified success of brazed construction—and assures its adoption on an ever widening scale in post-war manufacturing.

It will pay to keep EASY-FLO brazed construction in mind when you design. And it will also pay to check parts now being cast, forged or turned from the solid for opportunities of changing over to metal-labor-cost-saving EASY-FLO brazed construction.

It is also highly probable that you can speed up production, get better joints and cut costs on various ferrous, non-ferrous and dissimilar metal joining operations now being performed in your shop by changing to EASY-FLO brazing.

BULLETIN 12-A will give you full EASY-FLO details. Write for your copy today.

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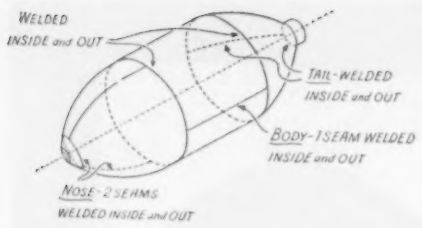


welding applications disclosed by officials of The Lincoln Electric Company, Cleveland, Ohio.

In the field of projectile fabrication alone, reports showed that tremendous savings are being effected in materials, time and man-power.

An outstanding example of the vital importance of the electric arc in our war effort is demonstrated by the widespread use of the process in the construction of huge 4000-pound blockbusters that are softening up Europe for the coming all-out Allied offensives.

These big 2-ton explosives measuring about 8 ft. in length and 9 ft. in circumference, are of arc-welded design and now require only 8 hr. welding time per bomb due to advanced technique in securing a better fit-up and employing time and labor saving jigs and positioners to speed up the work.

Parts for the structure are first flame cut and beveled on a jig, press formed cold to diameter, fitted and tack welded on rolls specially made for the purpose.

A special power-operated positioning fixture then tilts and rotates the assembly for laying the complete beads both inside and outside to complete the leak-proof construction.

The two rolling bands, seen in the finished bomb are hinge-pinned over the lifting lugs.

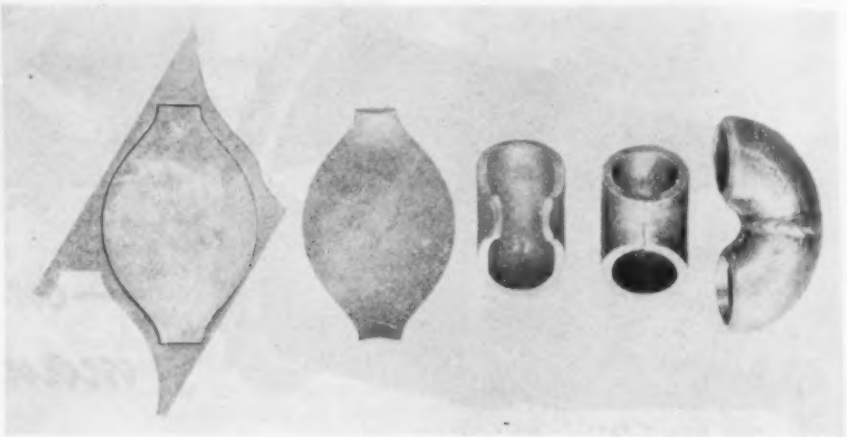
All welding is done with shielded arc electrodes of $^{3}/_{16}$ and $^{1}/_{4}$ inch size and of AMERICAN WELDING SOCIETY specification, E-6012.

The benefits of adopting the latest weld-engineering methods and recommendations are evident in the increased production of these bombs necessary for the stepped-up Allied air offensives.

WELDED RETURN BENDS FOR SHIP FITTINGS

The Weber Showcase & Fixture Co. of Los Angeles have converted their entire plant from peacetime products to the production of assemblies for Liberty ships and tankers. In their work of constructing ship funnels and King Posts for these ships there are many problems of specially designed parts that they are required to make.

In writing to the Hobart Arc Welding News, Mr. W. A. Pruett, research engineer



Photographs courtesy, The Hobart Brothers Co., Troy, Ohio

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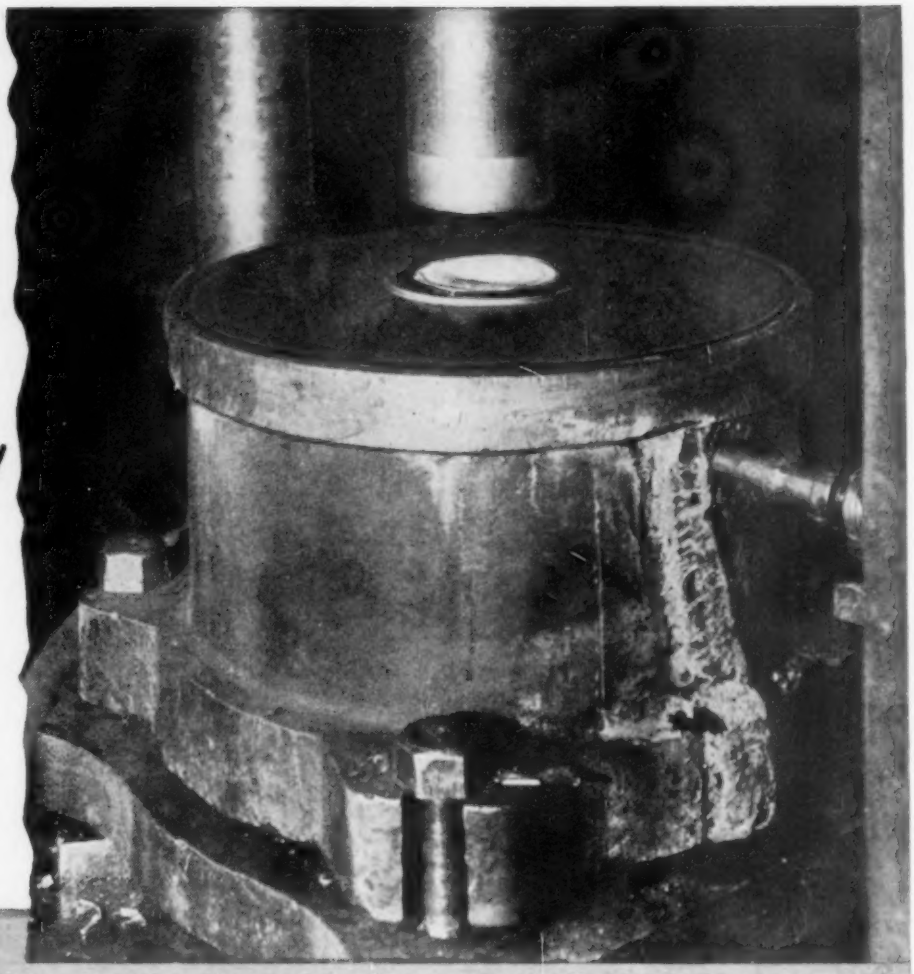
Bronze Repair Weld



RESTORES DISCARDED EXTRUSION DIE BLOCK

THIS OLD DIE BLOCK, once broken and discarded, is back on the job, working full time on a hydraulic extrusion press at the National Lead Company plant in Cleveland, Ohio.

Faced with a serious delay in obtaining a new block, this old-timer was brought out of retirement, its cast iron water jacket welded up the side with Anaconda 997 Low-Fuming Rod, and has been giving good-as-new performance in the production of extruded lead and lead alloy rod, wire and seamless tube for more than two months.

This salvage operation is only typical of the priceless emergency service rendered by such concerns as the Neal Welding Company of Cleveland, using Anaconda 997 and Tobin Bronze* for first aid in America's vital war production centers. Think of bronze welding before you think of scrapping any damaged machine part. 4488

*Reg. U. S. Pat. Off.

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ANACONDA

Anaconda Welding Rods

at Weber shows the five stages performed in making welded return bends for special ship fittings.

They are blanked and formed cold in four operations of $^1/_4$-in. plate. The welding champor is machined with double automatic spindles, and the two halves are rotated in jigs to be welded while the welding rod is stationary.

The elbows are $1^1/_2$ in. I.D. and bent on 3-in. center, making a very short throat. They are all tested at 500 lb. hydrostatic pressure.

RELATIONSHIP OF WELDING RESEARCH COUNCIL AND AMERICAN WELDING SOCIETY

By W. Spraragen*

Historical

March 1919–Fall 1920

The AMERICAN WELDING SOCIETY was organized in 1919 as an outgrowth of the work of the Welding Research Committee of the Emergency Fleet Corporation and the National Council of Defense, in World War I.

At the same time there was created a body known as the "American Bureau of Welding" which was to have charge of the Research and Standardization activities of the SOCIETY.

As the SOCIETY was young, it had to depend for its support largely on the manufacturers. There was considerable dissension among the manufacturers of apparatus for the different processes, and intense rivalry among individual units of a particular process. Small wonder, then, that the accomplishments of the Bureau during that period were practically nil.

* Executive Secretary, Welding Research Council, 29 West 39th St., New York.

Fall 1920–Fall 1926

The AMERICAN WELDING SOCIETY accepted the offer of National Research Council to reorganize the American Bureau of Welding under the joint auspices of the Council and the SOCIETY, with representation from other engineering and scientific bodies.

During this period the work of the Bureau was roughly divided into three parts:

1. Standardization and Code work.
2. Dissemination of Research Information.
3. Research.

Examples of Standardization and Code activities are indicated by the following titles of reports produced: Standards for Arc Welding Apparatus, Welding Wire Specifications, Standards for Testing Welds, Training of Welding Operators, Standards for Resistance Welding Apparatus, Resistance Welding Nomenclature, Specifications for Steel to Be Welded, Welding of Storage Tanks.

Examples of Research Information reports produced are: Welding Manganese Steel, Arc Welding in Ship Construction, Reviews on Resistance Butt Welding, Electro-Percussive Welding, Arc Welding of Non-Ferrous Metals, Welding of Cast Iron, Welding as a Method of Fabricating Large Structures, Welding Mild Steel, Fluxes and Slags in Welding.

Examples of the research committees are: Welded Rail Joints, Structural Steel Welding, and Welding of Pressure Vessels.

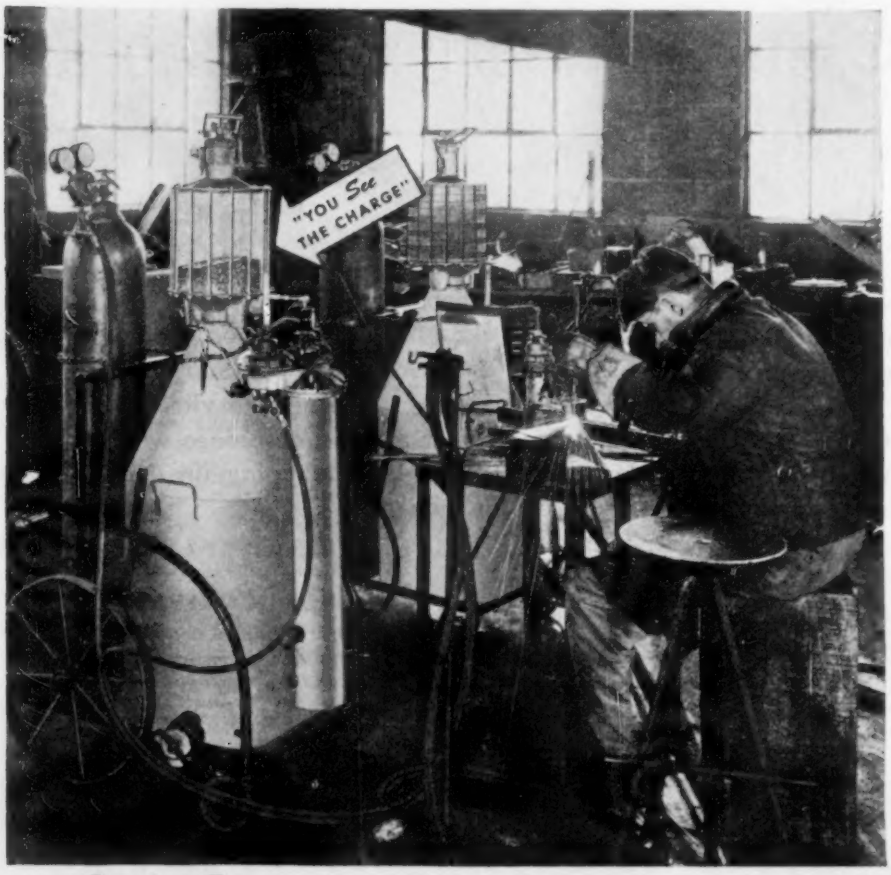
Fall 1926–Spring 1933

At the close of the era immediately preceding the period indicated above, it became apparent that some reorganization was necessary.

The Standardization activities were not truly representative of industry as they were largely dominated by the manufacturers, and necessarily so as they had the requisite knowledge. The Research Work was of a practical nature, dictated pretty largely by the needs of the code or standardization activities. No funds were forthcoming from industry for fundamental research.

In the fall of 1926, The AMERICAN WELDING SOCIETY created its own Technical Department and appointed a Technical Secretary. It took over the standardization and code activities of the American Bureau of Welding. Released from these activities the American Bureau of Welding concentrated on Research Work. It abolished its process committees, and while continuing a few large research projects, it made a determined effort to undertake fundamental research.

The Fundamental Research Committee was organized under the chairmanship of H. M. Hobart. With no financial



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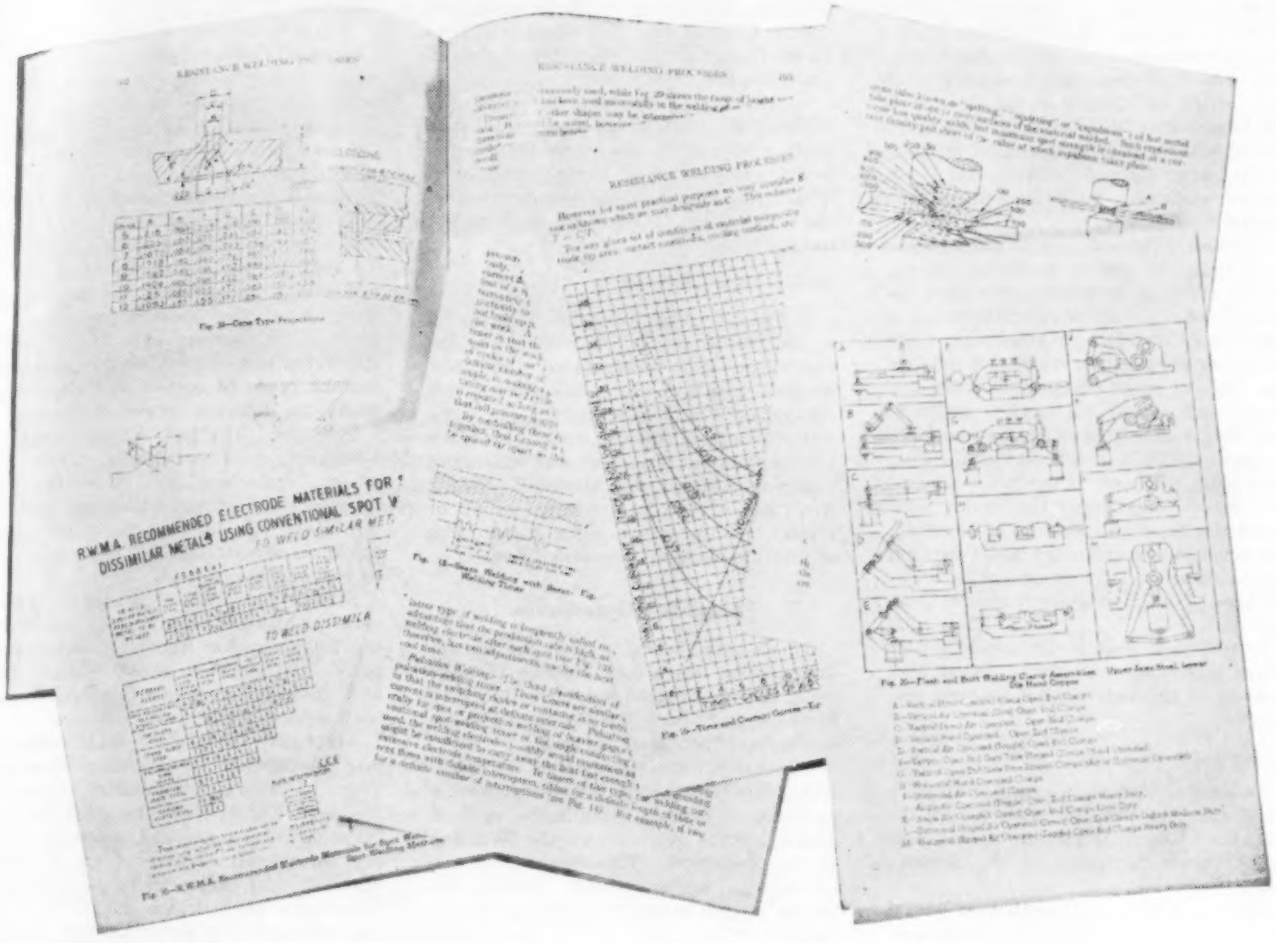

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support from industry, and very modest support from the National Research Council and Engineering Foundation, this committee stirred up considerable active interest in a large number of universities and started more than fifty research projects. Most of these projects were small and carried out largely at the expense of the universities, usually under the direction of professors whose interest in welding had been aroused, with the aid of advanced students; sometimes they were merely Senior theses.

During this period a large share of the most valuable papers presented at the annual meetings of the SOCIETY were the outcome of the work of this Fundamental Research Committee. Moreover, even the minor projects not worthy of publication were of great educational value and constituted one of the major factors in spreading a knowledge of the fundamentals of welding. In fact, the work of the Fundamental Research Committee during this period constituted the major service of the American Bureau of Welding. Moreover, it was continued under the later organizations and is now operating under the head of our University Research Committee.

At one time during this period an attempt was made to interest the A.W.S. Sections in this activity but without success.

Spring 1933–Fall 1935

National Research Council suffered a severe loss in income and asked the AMERICAN WELDING SOCIETY to take over the Research Activities of the Bureau, which the Society did.

During this two and a half year period the SOCIETY concentrated on the liquidation of the Welded Rail Joint Committee and the Structural Steel Committee. It was unable to act effectively in the matter of securing funds for Fundamental Research. Most companies when approached felt they were doing enough in maintaining their sustaining membership in the SOCIETY. (The process of liquidation of the Bureau actually continued through 1936.)

Fall 1935–January 1943

About this time The Engineering Foundation stated that it would be willing to organize a *Welding Research Committee* if the SOCIETY would join with the A.I.E.E. in sponsoring the Committee. It agreed further to contribute $5000 a year, provided the efforts of the Committee would at first be devoted largely to critically digesting the world's literature, and provided at least an equal sum could be raised from industry.

Needless to say, the AMERICAN WELDING SOCIETY seized the opportunity. It quickly abolished the American Bureau of Welding. It transferred the Fundamental Research Committee to the Welding Research Committee. It changed its By-Laws to permit the Welding Research Committee to operate independently.

In the brief period of one year, the Welding Research Committee established itself and the Engineering Foundation funds were matched three times over. Thus, the long period of education in the importance of Research work began to bear fruit.

January 1943 to Date

In January 1943, after careful study by a prominent group of executives, the Committee was reorganized internally without effecting the relationships with AMERICAN WELDING SOCIETY. The work was streamlined for war work. Its three Division system, Fundamental, Industrial and Literature, was abolished. Work was concentrated in a selected group of project committees. The name was changed to Welding Research Council.

Present-Day Organization

There were several reasons for the reorganization which took place in January 1943, the chief reason being the difficulty in drawing a sharp line between Fundamental and Industrial research.

Under the new organization the work was divided into active projects under the guidance of project committees, each of which reports directly to the Welding Research Council. This was enabled the Council to assure greater coordination among project committees, and to stimulate progress.

The present Project Committees and their purposes are:

LITERATURE.—*Chairman:* J. H. Critchett, Vice-President, Union Carbide and Carbon Research Laboratories, Inc. To make available in readily usable form the welding research information existing in the literature of the World.

UNIVERSITY RESEARCH.—*Chairman:* H. C. Boardman, Research Engineer, Chicago Bridge and Iron Company. To promote and conduct fundamental welding research in the universities, and to maintain contact with some 50 research projects in the leading universities of this country. This committee really serves exactly the same function as that of the old Fundamental Research Committee of the American Bureau of Welding as explained above, although it now receives a much larger share of the financial support. It not only has great educational value in the training of future welding engineers, but is also the breeding ground for most of our major projects which are later taken over by special project committees. It is still the source of many of our best papers.

WELD STRESSES.—*Chairman:* Everett Chapman, Consulting Engineer. To evaluate residual or thermal stresses due to welding, to discover optimum conditions of control, and to study their effect on the serviceability of various types of welded structures.

WELDABILITY.—*Chairman:* A. B. Kinzel, Chief Metallurgist, Union Carbide and Carbon Research Laboratories, Inc. To evaluate and control each element of weldability as affecting the base metal, weld metal and joint as a whole; to provide the engineer with basic data for specifying suitable welding procedures for various types of carbon and alloy steels under the different service conditions.

FATIGUE TESTING (STRUCTURAL).—*Chairman:* Jonathan Jones, Chief Engineer, Bethlehem Steel Company. To provide the engineer with basic unit design data for different types of joints, thickness of materials, and steels subjected to varying service loads.

STRUCTURAL STEEL RESEARCH.—*Chairman:* LaMotte Grover, Structural Welding Engineer, Air Reduction Sales Company. To develop useful design data and information needed in connection with welded bridges and buildings.

AIRCRAFT.—*Chairman:* G. S. Mikhalapov, Supervisor of Welding Research, War Metallurgy Committee, National Research Council. To establish the application of arc, gas and resistance welding in aircraft structures on a sound scientific and engineering basis; to provide engineering design data; to establish optimum welding procedures.

RESISTANCE WELDING.—To establish optimum welding procedures for each of the processes of resistance welding for different materials and sizes.

LIGHT ALLOYS.—*Chairman:* G. O. Hoglund, Welding Engineer, Aluminum Company of America. To conduct fundamental research in arc, gas and resistance welding and brazing of aluminum, magnesium and their alloys; to cooperate with other committees in their researches on these materials.

NICKEL AND ITS ALLOYS.—*Chairman:* O. B. J. Fraser, Superintendent, Technical Service on Mill Products, International Nickel Company. To conduct fundamental researches on the arc, gas and resistance welding of Nickel, Monel and Inconel.

HIGH-ALLOY STEELS.—*Chairman:* S. L. Hoyt, Battelle Memorial Institute. To carry out fundamental research on arc, gas and resistance welding of chrome-nickel steels; effect of substitution of

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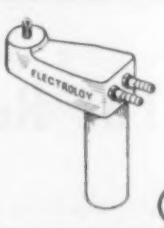

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Five years experience and over 200 industrial plant users have proven the Nelson Electric Arc Stud Welder to be the simplest, most-flexible means of automatically end-welding studs to metal surfaces. *With it an operator can make from 500 to 1000 welds per shift.* Here's what it is . . .

The Nelson Model H

Here's a stud welder—Light in weight, flexible in position, fully automatic in operation are features *only* found in the Nelson Stud Welder. With it welds are made in *less than one-half second*. The stud is put in the chuck end of the unit and placed in contact with the steel plate . . . by pulling the trigger the gun automatically welds.

Here are studs—They're made in several sizes and styles for various uses. The Nelson studs are patented "flux-filled" all-position welding studs. They are available in diameters of ¼" to ½"—in overall lengths of 1" to 8". Insulation of all types may be secured with the patented Nelson Insulation Pin.

Here's a stud weld—The weld is stronger than the stud. Complete fusion of the stud to metal results from a fully shielded arc. The stud is placed in the gun, contacted to the metal, and the operator pulls the trigger. This causes the current to retract the stud establishing an arc from the stud to the plate. Zip! And the gun plunges the stud into a molten pool of metal completing the weld. *There's no hole made to weaken the metal parts!*

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other elements such as manganese, clad steels, and the effects of corrosion.

Relation to N.D.R.C.

When it became evident that this country would become involved in the present war, the Welding Research Council oriented its activities to assist in the war effort. It offered its services to the government as a body, but was not accepted as such an arrangement did not fit in with the organizational scheme of the National Defense Research Committee. Instead, welding was placed under the War Metallurgy Committee of the National Research Council.

The Welding Research Council placed its facilities at the disposal of N.D.R.C. and the War Metallurgy Committee. It spent its funds in formulating problems, getting them started, and in turning them over to N.D.R.C. It abandoned its own work temporarily where the facilities were needed by N.D.R.C. Where governmental red tape caused lapses between contracts with institutions, or where work had to be supplemented, it quickly stepped in and provided the necessary funds to keep research crews together, or to increase the usefulness of the results where such work would not be possible because of a more indirect bearing to the war effort. This help has been acknowledged by the laboratories and by the War Metallurgy Committee.

In turn, the Welding Research Council is greatly indebted to N.D.R.C. for all the worth-while research made possible by its influence and its funds. Where projects come under the general advisory influence of committees of the Welding Research Council, the War Metallurgy Committee has been most helpful in the selection of its project control groups.

All in all, the arrangements have been for the most part satisfactory and worth while.

Not all N.D.R.C. welding projects come under the supervision of committees of Welding Research Council. Many of them relating to armor plate are confidential. In one other, a large project on Weld Stresses at the University of California, it has seemed best to the War Metallurgy Committee to deal directly with a Technical Committee of the AMERICAN WELDING SOCIETY, namely, the Hull Construction Subcommittee of the Marine Committee. This affiliation is with the individuals of the committee, rather than with the committee as such.

Financial Support of Welding Research Council

As stated above, the financial support started with a contribution of $5000 a year from Engineering Foundation, supplemented by much larger contributions from industry. From the very outset governmental support was solicited and obtained for specific projects. Since the War this governmental support has assumed large proportions. At the present time at least seven government agencies contribute to the Council's work.

In addition, the Council derives considerable support from trade associations. It receives token payments of $250 a year from several national engineering societies (but not from the AMERICAN WELDING SOCIETY).

One of the most acid tests that may be applied to any organization of this sort is the continuance of its contributors. By this yardstick the Welding Research Council must be considered pre-eminently successful. It has lost very few (3 or 4) of its contributors, and these contributors have made it clear that it was not because of lack of interest, but because of financial difficulties on their part.

Tie-in with American Welding Society

Although it enjoys freedom of operation, the Welding Research Council is considered as the Research Department of the AMERICAN WELDING SOCIETY. In 1936, Welding Research Council with Engineering Foundation's approval, adopted THE WELDING JOURNAL as its official organ. A financial relationship was entered into with AMERICAN WELDING SOCIETY (approved by Board of Directors) whereby Welding Research Council contributes half the cost of type setting, "make-ready" and cuts amounting at present to $5000 per year. Six hundred and forty journal pages were published in 1943. In this way the entire membership of AMERICAN WELDING

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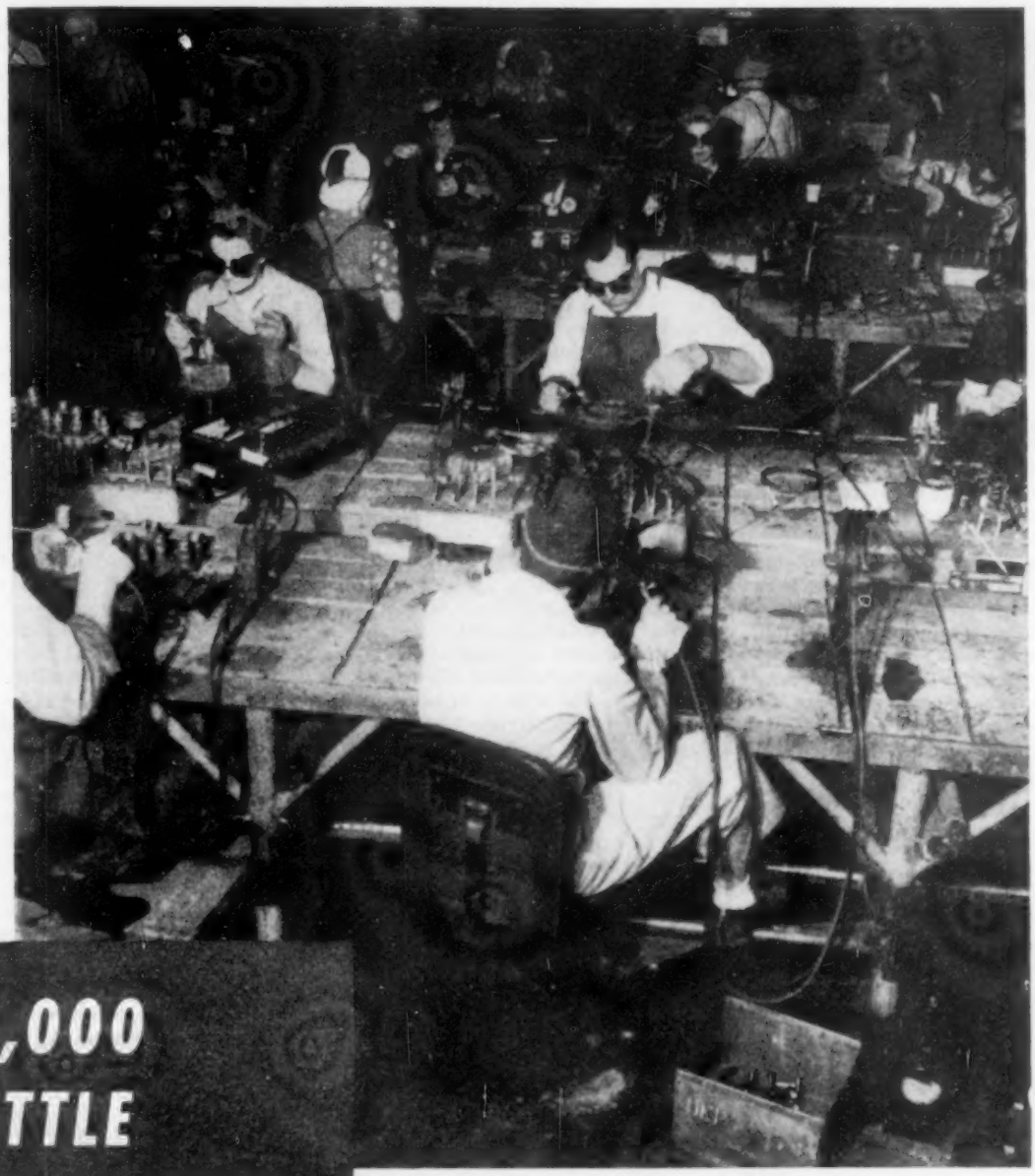

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SOCIETY derives the benefit of the work of Welding Research Council.

The administration of the work of the Council is in the hands of outstanding research-minded executives representing the principal contributing groups. Among the Council's membership are included the present President, 1st Vice-President, 2nd Vice-President, 5 Past-Presidents and several Directors of the AMERICAN WELDING SOCIETY.

Projects are under the advisory guidance of committees of competent experts. At the present time more than 80 members of project committees are members of the technical committees of A.W.S.

The relationship of the Welding Research Council and AMERICAN WELDING SOCIETY is similar to that of other projects of The Engineering Foundation and the corresponding societies.

By having the *Welding Research Supplement* a part of THE WELDING JOURNAL, the members of the A.W.S. not only get the advantage of the reports of Welding Research Council but the JOURNAL is also made more attractive to its advertisers. Fully one-third of the Annual Meeting papers each year deal with research work of Welding Research Council, or reported to it by affiliated members. Through the Council's contacts with 30 leading universities the SOCIETY has been made better known to the leading colleges.

Questions

For the first time in its eight years of operation under The Engineering Foundation, several questions have been raised as to the desirability of this connection. These questions, which to the best of our knowledge originated in the minds of one or two members of the A.W.S. "Outline of Work" Committee, are briefly as follows:

(*1*) *Why should not Welding Research Council be placed directly under the American Welding Society?*

There are several answers to this question:

(*a*) We would obviously lose the prestige of Engineering Foundation and its financial support, which is now $4000 per year (exclusive of certain services estimated at $600 per year).

(*b*) Engineering Foundation is operated by a Board chiefly representative of the four Founder Engineering Societies, one of which, A.I.E.E., is co-sponsor for the W.R.C.; and two of which, A.I.E.E. and A.S.C.E., are regular contributors to W.R.C. It obviously would be very difficult to get these contributions, or even the same kind of cooperation if W.R.C. were just another committee of A.W.S.

(*c*) It is also probable that some of the governmental agencies would prefer to deal with a broadly representative National Research Foundation rather than with the A.W.S.

(*d*) In short, we have much to lose and it is difficult to locate any gain.

(*2*) *Should there not be some official connection between the A.W.S. and the W.R.C., such as one or more official representatives selected by the A.W.S. Board?*

(Answers) As long as W.R.C. is responsible to The Engineering Foundation, its members must be appointed by the Engineering Foundation Board. If at any time the A.W.S. Board is not satisfied with its representation, its wishes would certainly be given very serious consideration. In this connection it should be noted that the present membership of W.R.C. includes the present President of A.W.S., the 1st and 2nd Vice-Presidents, several Directors and five Past-Presidents. Most of the other members of W.R.C. are prominent and very active members of A.W.S.

(*3*). *Would not a closer cooperation between the technical committees of A.W.S. and the W.R.C. be advantageous?*

With the present setup it is difficult to see how closer cooperation could exist.

Before citing cases in illustration of this close cooperation, it may be well to review briefly the present general setup.

Although there is no sharp line between industrial and fundamental research, and although all of our research work is aimed eventually at industrial applications or service to industry, there is a considerable difference in the two methods of attack. These differences are clearly illustrated by some of our present projects which may be distinguished as largely empirical on one hand (Fatigue Research on Structural Welds and Structural Steel Projects) and more fundamental, rational or scientific on the other hand (Weldability Project and some of the Weld Stress Projects).

In the former case, members of the

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PRECISION CONTROL
Variable Core construction permits stepless heat changes while welding. Magic Eye-Pilot indicates when machine is on.

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Instantly starting, smooth, flexible. Elimination of "arc blow" produces sound, speedy and uniform welds. X-Ray test beads.

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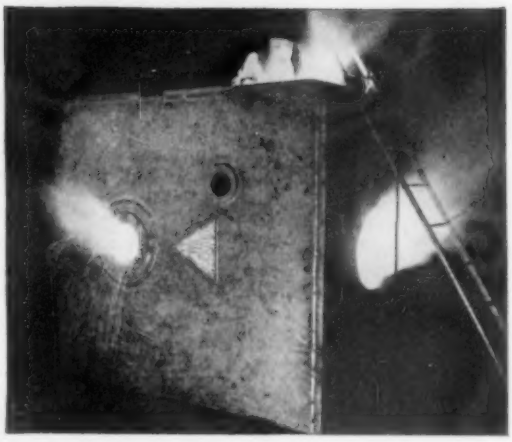
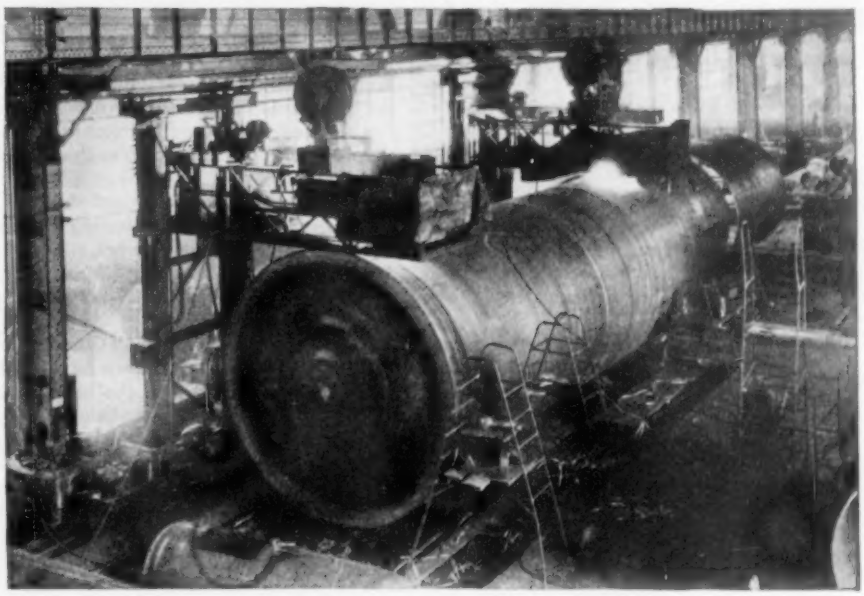
AUTOMATIC WELDING has many advantages in fabricating boiler drums, cracking stills and other products for which repetitive welding is practical. Deposit rate is often greater because of the use of higher currents, and a larger ratio of welding time to working time, compared with manual welding. The strength and high quality of the weld are due to the close control of the arc and the excellent fusion possible at high currents using Murex Electrodes.

Murex rods available for automatic welding are Type F, Carbon Moly. 50 and Cromansil. The spiral asbestos winding of these rods anchors the coating to the core wire so that the electrodes may be coiled without cracking and also provides an absolutely concentric coating that does not spawl off under the slitter.

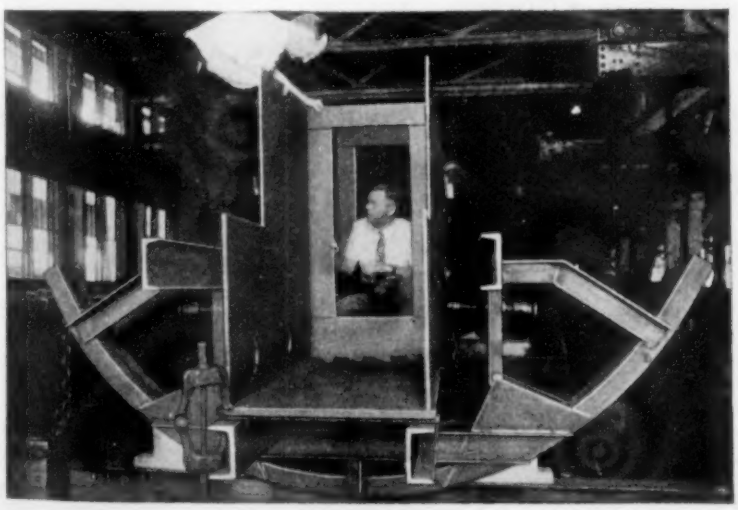


THIS STRIKING action photograph illustrates the use of Murex Electrodes in welding the top member of a single action, single eccentric press, fabricated by Clearing Machine Corporation. Press frames are positioned with only four turns. The sides weigh from 80,000 to 90,000 lbs. and some plates are 10″ thick. Double-Vee welds, back-stepped, are employed.

HUGE PRESSURE VESSELS over 6′ in diameter, up to 35′ long and having a shell thickness of 4″ to 5″ are welded automatically by Foster Wheeler Corporation with Murex Type F and Carbon Moly. 50 electrodes in continuous coils. The soundness of the weld metal is shown by the fact that as many as 44 longitudinal boiler drum seams have been welded consecutively, with only five minor defects showing up under X-ray examination.



CRANE GIRDERS are subject to severe overloads and the shock of sudden stops and quick reversals. Manning, Maxwell & Moore, Inc., applying a special technique, uses Murex Electrodes in the construction of its "Shaweld" crane girders. They are much stiffer laterally than riveted girders and more resistant to the twisting motion set up by the driving machinery. Positioning cradles are used to permit downhand welding on the girders which are exceptionally long and heavy.



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Specialists in welding for nearly forty years. Manufacturers of Murex Electrodes for arc welding, and of Thermit for repair and fabrication of heavy parts.

Project Committees are almost wholly representative of industry and are usually members of the A.W.S. technical committees. Thus, the results of this research are immediately put to work by our technical committees and by the industries concerned. The tie-in between this phase of the work of W.R.C. and that of our technical committees is certainly as intimate as could be possible.

In the case of the more rational or scientific type of research, members of the project committees include a larger percentage of the scientific type, either professors or scientific engineers connected with industry. But even in this case the ultimate objective of service to industry is kept in the foreground, and every effort is always made to put the results in such shape as to be applicable by those concerned with their application, even when the latter may not be conversant with the more scientific aspects of the problem. These results, with the technique of their application, are published at the earliest possible moment. As an illustration, consider the first stage of the Weldability Project carried on at Lehigh and Rensselaer Polytechnic Institute.

In both cases the results are published in the *Welding Research Supplement* of the A.W.S. JOURNAL, and half of the expense of this publication is borne by W.R.C.

There follows a list of specific cases illustrating the very close cooperation and close tie-in between W.R.C. projects and the Technical Committees of the A.W.S.:

1. Our carbon-manganese program was in part brought about to test the validity of the A.W.S. Bridge Specifications on Materials.

2. The work at Lehigh and R.P.I. was devised to provide a more fundamental approach to weldability. The Program was approved by the A.W.S. Marine Committee. The Lehigh work is being used in the new Bridge Specification.

3. A portion of our Weld Stress investigations was approved by the A.W.S. Marine Committee and the two reports of the Thermal Stress Committee make use of this work.

4. The Fatigue and Structural Steel Research committees were created at the request of A.W.S. Technical Committees and have been guided largely by the Bridge and Building Code committees of A.W.S. The research results have been used widely by the A.W.S. committees.

5. More than 18 Literature Digests were undertaken to supply information needed by Technical Committees of the A.W.S. A partial list is as follows:

Strengthening Existing Structures under Load, Residual Stresses, Distortions in Welding, Impact Resistance of Welded Joints, Cold Weather Effects, Cracking in Welds, Bend Tests of Welded Joints, Stress Distribution in Fillet Welds, Effect of Carbon and Manganese on Weldability, Welding Silicon Steels, Effect of Sulphur and Phosphorus on Weldability of Steels, Effects of Carbon on the Welding of Plain Carbon Steels.

6. The Resistance Welding and Aircraft Research Committees have the same Chairmen as corresponding committees of the A.W.S. Work of the Research Committee has formed the basis for all reports issued by the Standards Committees in these fields to date.

7. The work of the Literature Committee was the basis for the wide acceptance of A.W.S. Standards for Testing Welds by other societies. The Resistance Welding Research Committee initiated the Standards for Testing Spot Welds.

8. Twenty-nine committees preparing chapters of the *A.W.S. Handbook* used material of the Welding Research Council.

9. Educational books published, and in process, by A.W.S. are based in whole, or in part, on the research work of W.R.C. These include *Welding Metallurgy, Practical Design of Welded Structures* and *Guide Book to Weldability.*

10. The U. S. Maritime Commission and the U. S. Army Ordnance have made public acknowledgment of the helpfulness of the work of the A.W.S. and the research activities in back of these efforts.

This somewhat lengthy review of the present setup and its operation is presented since it seems to the writer that most of the recent questions are based upon a lack of full knowledge of the present situation, and is not intended in any way as a defense of that situation.

If after a careful review of these facts by the Board of Directors or Executive Committee of A.W.S., they have any suggestions as to constructive organizational changes which will make for greater efficiency without sacrificing any of the advantages of the present setup, such suggestions will be gladly accepted.

Finally, although the W.R.C. is for all practical purposes the research branch of the A.W.S., it is not a committee of the A.W.S., but is a committee of The Engineering Foundation under an arrangement which was gladly accepted by our Board of Directors at a time when the SOCIETY as such was making little progress with its Research Committee.

ANNUAL MEETING

A.W.S.

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Write to

Housing Committee,
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1604 Terminal Tower Bldg.,
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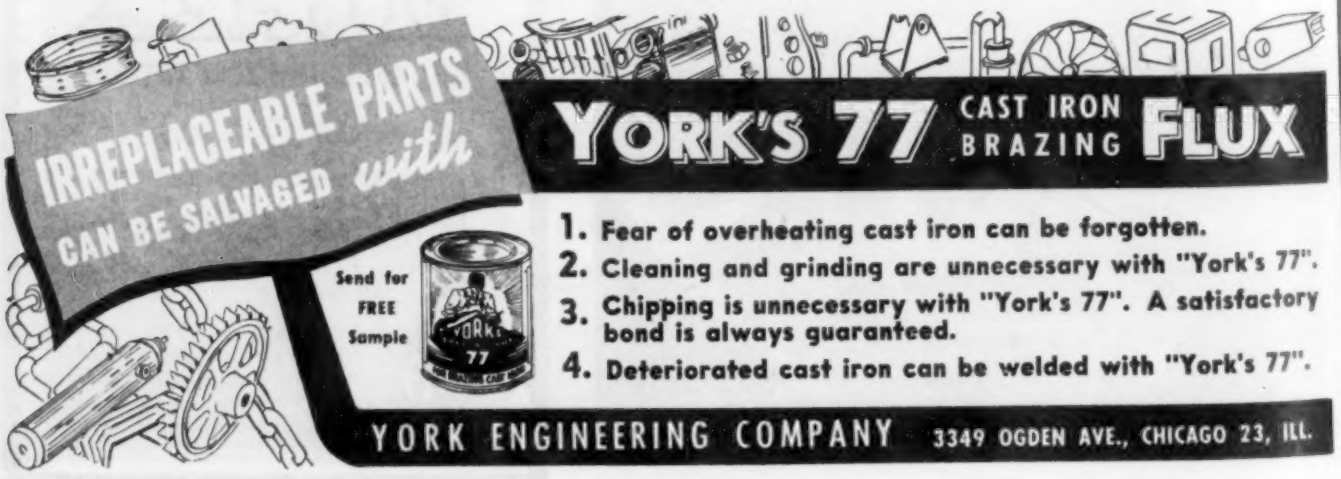
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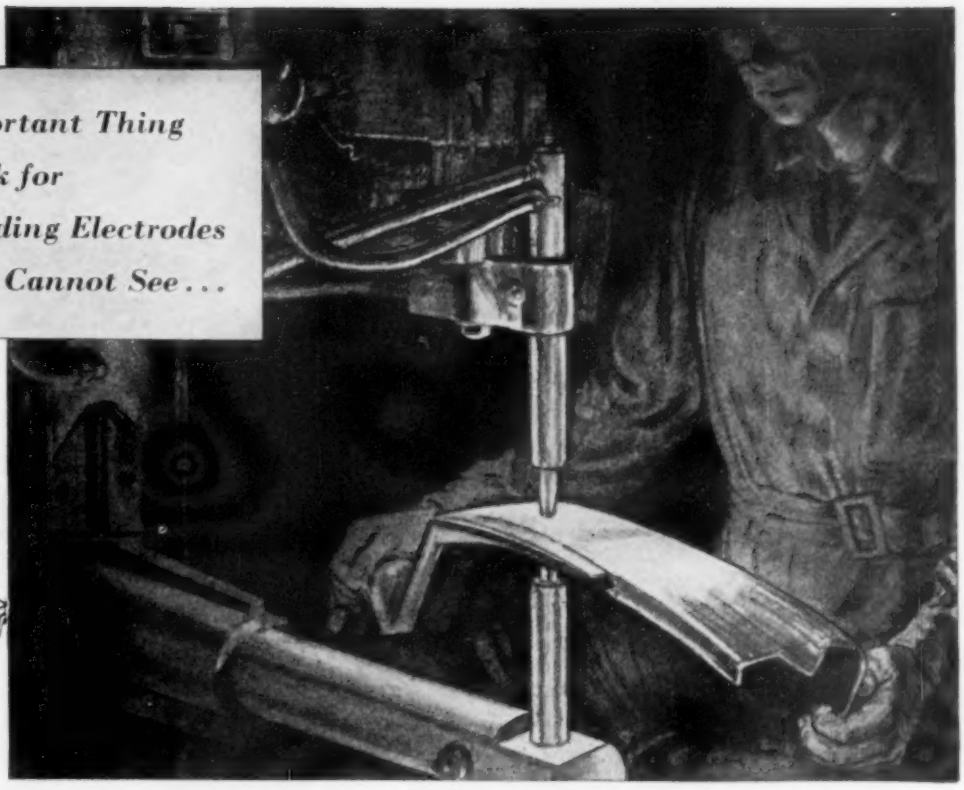
The Most Important Thing
To Look for
in Resistance Welding Electrodes
is Something You Cannot See . . .



MALLORY Engineering Skill . . . For Better Alloys and Sturdier Electrodes

Back of every Mallory resistance welding product is a mass of engineering information, invisible to the customer, but of the utmost importance to him. From this accumulated knowledge have come many important advancements in the field.

In the design of resistance welding electrodes and holders, Mallory engineers anticipate trends in the industry with products that do the job better at less cost. While the products are being built, they constantly test their quality and fitness. And after they are placed in service, they check their performance for possible improvements.

As a result, Mallory today gives you alloys—Elkaloy*A, Mallory 3 Metal, Elkonite* and many others—of higher electrical conductivity and wear resistance. It offers as items of *standard equipment* electrode sizes and shapes which formerly had to be made to order. In the even better products of tomorrow, Mallory customers will find the results of today's research.

This invisible factor—Mallory engineering—is at your disposal whenever you have a problem regarding resistance welding electrodes or their use. Let us demonstrate how it can help you.

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**Reg. U. S. Pat. Off. for refractory metal compositions*

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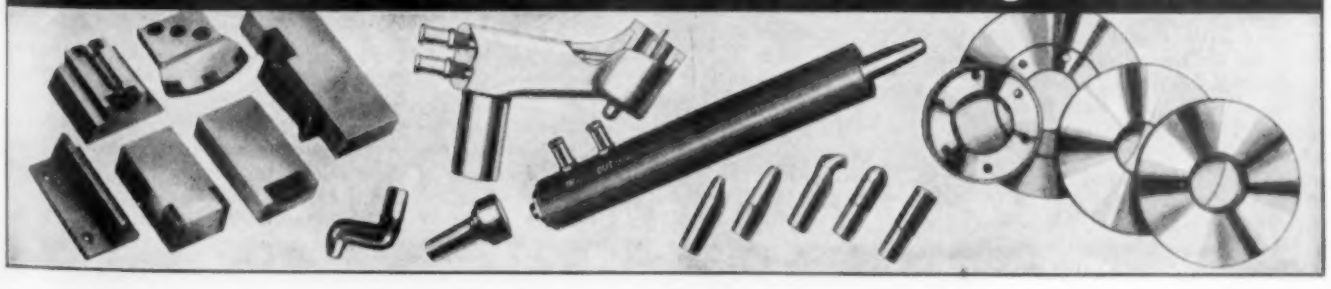
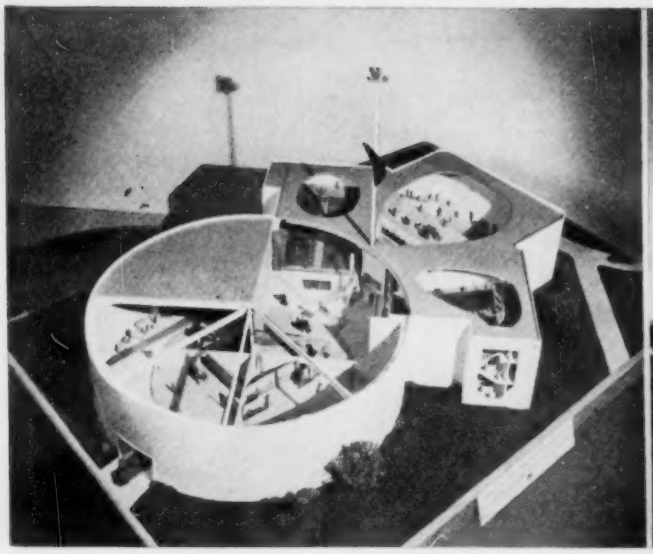
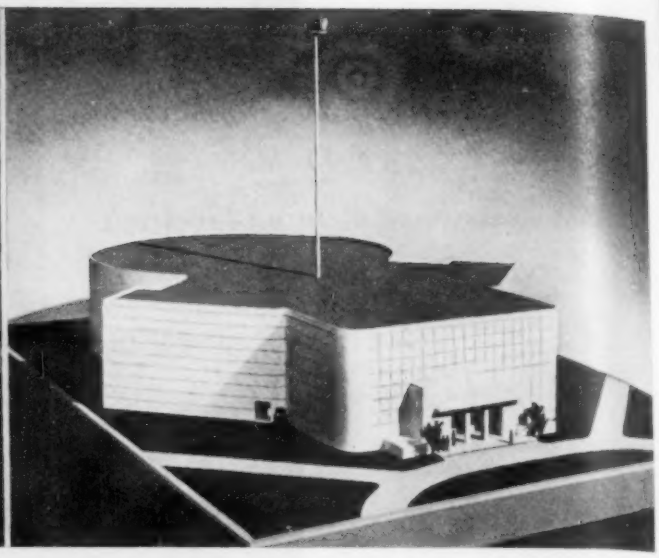
MALLORY *Standardized Resistance Welding Electrodes*







MODEL OF POSTWAR TELEVISION STUDIO EXHIBITED

A working model of television studios designed for the postwar broadcasting of regular commercial network programs with large studio audiences was exhibited by engineers of The Austin Company, on April 6th, at the Waldorf-Astoria Hotel.

The model was "unveiled" at a press luncheon where Dr. Walter R. G. Baker, vice-president of General Electric Co. and other G-E officials discussed "Television Postwar" and announced the company's plans for the new industry.

Austin engineers have developed a basic new building design for the studios, with a turntable stage and unique layout which make it possible to accommodate rapid changes of scene and audience without duplication of costly television equipment.

Separate audience seating areas, each accommodating several hundred people, are provided on either side of a single broadcasting control room and overlook one quadrant of the revolving stage from which all productions are to be broadcast. Sound-resistant curtains across the front of each seating area make it possible to use the two sides alternately for alternate programs, or jointly when desired. When the curtain is drawn on one section, at the end of a program, spectators can leave it and a new audience can assemble there for a later program without disturbing the next succeeding broadcast which is viewed meanwhile from the other audience section.

The design was adopted following a study of facilities and experience at G-E's television station, WRGB, Schenectady, and in the light of Austin's experience in the design and construction of facilities for communications and entertainment industries.

The studios have been planned along modern, functional lines with a welded rigid frame steel structure which supports several cantilevered television cameras, as well as the circular roof in the stage area. With one of these cameras mounted on the pivotal column in the center of the revolving stage and the others on the sides, it is possible to cover every part of the stage, at any distance and from every angle. The same cameras can be directed toward the audience for visual broadcasts of audience participation.

GALV-WELD ALLOY

A relatively new process entitled "Galv-Weld Process" has been developed by Galv-Weld, Inc., Dayton, Ohio. This process makes it possible to regalvanize at the time of welding. The heat of welding, of course, destroys the galvanizing for a certain distance next to the weld. This portion may be repaired by the process mentioned above. The following procedure is indicated.

Residual Heat Method (for Use with Uncoated Rod)

1. Make weld in usual manner.
2. Brush weld with wire-bristled brush while it is still hot, to remove scale.
3. Galvanize by rubbing bar of Galv-Weld Alloy back and forth over the weld while it is still hot enough to melt same. The area in which the galvanizing is destroyed will be hot enough to melt the alloy making a self-limiting method.
4. Again brush the weld while the alloy is in a liquid state so as to spread evenly over the entire weld. Allow to cool in usual manner. No artificial cooling.

Regalvanizing Welds Made with Coated Rod

1. Make weld in usual manner and allow to cool.
2. Remove slag with chipper, grinder or other convenient means and clean with a wire brush.
3. Heat the weld and adjoining surface to be regalvanized to approximately 600° F. (NOTE: Galv-Weld Alloy melts at 450° F., thus it can be used as its own temperature indicator. If the weld is overheated the alloy will dross; if underheated it will not flow.)
4. Brush weld quickly with wire-bristled brush to remove scale or impurities.
5. Apply coating of Galv-Weld Alloy by rubbing bar of alloy over the heated surface while it is still hot enough to melt same.
* 6. Brush again while the alloy is in a liquid state to spread evenly and fix to surface to be regalvanized. Allow to cool normally. No artificial cooling.

"HIGH HARDNESS" ELECTRODES

A new line of Frostpoint refrigerated resistance welding electrodes with replaceable Frostcaps of Mallory-3 metal has just been announced by Frostrode Products, 19,003 John R, Detroit 3, Mich. Designed for welding operations requiring high electrode pressures, the new caps of high strength and hardness provide increased durability in severe, high-production service. Construction of the electrode is similar to other types of Frostpoints designed for normal electrode pressures in which hard drawn copper is used for maximum electrical and thermal conductivity. The finned internal surfaces of the Mallory-3 Frostcap distribute the coolant uniformly assuring accurate control of cooling and resulting in reduced pickup, more spots before cleaning and long electrode life, it is claimed.

Available in $^5/_8$ in. or $^7/_8$ in. O.D., the new Frostcaps may be used with any standard or offset Frostpoint electrode.

ECONOMY OF WELDED DESIGN SHOWN IN EMERGENCY CONSTRUCTION OF 250-TON PRESS BRAKE

Among the hundreds of instances reported on the application of welding to produce critically needed parts and equipment which, in many cases, is unobtainable through regular supply channels, was that of the fabrication of a 250-ton press brake pictured in the accompanying illustrations furnished by The Lincoln Electric Co., Cleveland, Ohio.

Conditions under which this press brake was constructed were outlined in a letter from the Truitt Manufacturing Co., steel

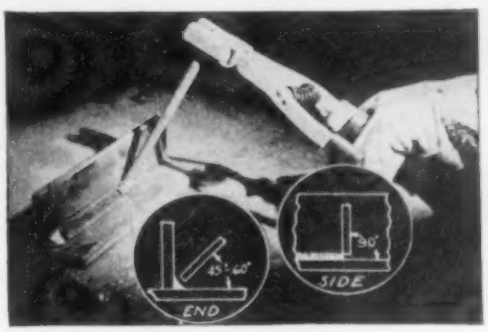
"Imitate in good things," he says

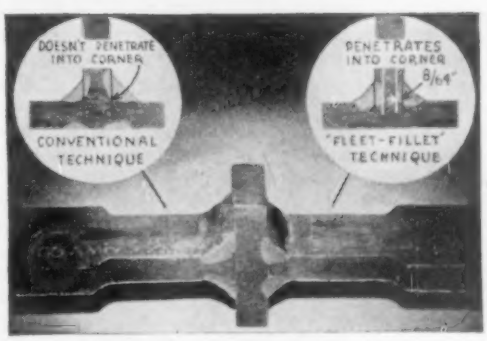
Here, Generalissimo, is a GOOD THING to imitate . . . the *faster production* being obtained by many aggressive users of this new Lincoln development:

A GOOD THING IN FILLET WELDING

The "Fleet-Fillet" Technique with "Fleetweld 11" has doubled the speed of many fillet welding operations. For example, 3/8" fillets, formerly made at 30 ft. per hr., are being "Fleet-Fillet" welded at 65 ft. per hr. In the comparison illustrated at the right, the fillets made by the "Fleet-Fillet" Technique have 70% as much deposited metal as those of conventional technique yet the "Fleet-Fillet" welds are 15% stronger.

Bulletin 432 gives complete details and procedures. Free on request.





HOW TO USE IT . . .

Procedure in applying the new technique consists of:

1. Hold electrode at an angle as shown in above illustration.
2. In general, use higher currents.
3. Advance electrode at higher speed.
4. Use electrodes recommended for the technique.

These general principles and their variations are discussed in Bulletin 432.

THE LINCOLN ELECTRIC COMPANY • Cleveland 1, Ohio

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ARC WELDING

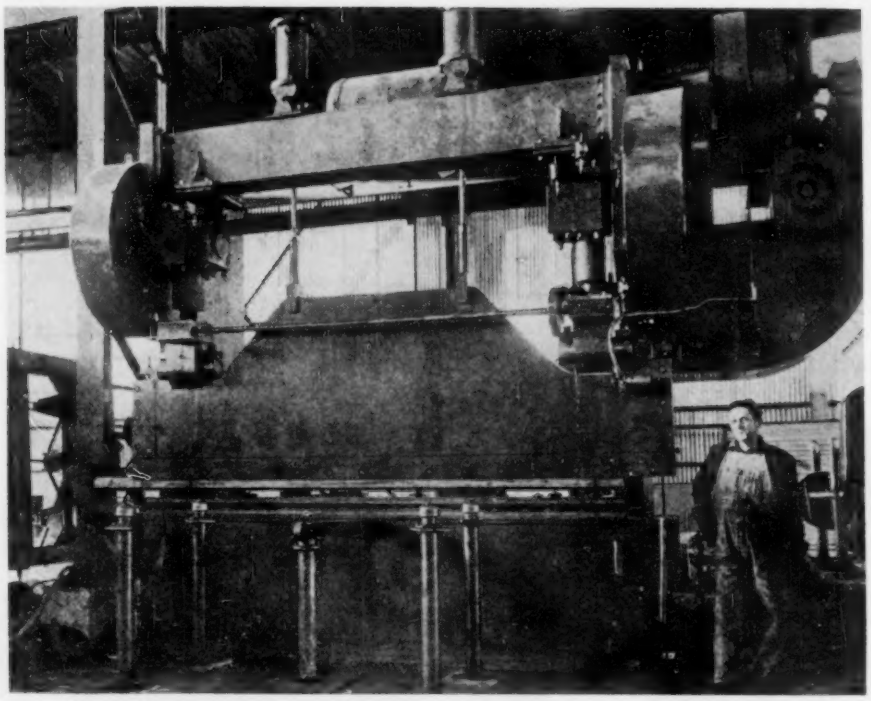


Fig. 1—General View of 250-Ton Press Brake of Welded Construction

fabricators of Charlotte, N. C., which says in part:

"More than a year ago it became apparent that we simply had to have a press brake if we expected to do any appreciable amount of plate work. Quotations were secured from different manufacturers, but the promise of delivery was rather indefinite. Nevertheless, we applied to the War Production Board for a priority to buy a brake. In spite of the fact that they admitted we certainly did need a brake, they, nevertheless, turned us down flat on the priority. We then asked for a priority for not over 50 tons of heavy plates from which to build a brake. This was granted, and we immediately went into the designing and then into the detailing of the brake we wanted. That, of course, involved a great many problems both from a standpoint of stresses to be considered and of mechanical construction. This design work, and the detailing, were completed as rapidly as possible and we thought we were fortunate in getting prompt shipment on the plates which we actually required. As a matter of fact, it only took approximately 30 tons of heavy plate.

"Mechanical details had to be rather carefully considered because of limitations of machine tools, especially as to planer capacity which we could find in this immediate territory. It was for this reason that we decided the top and bottom girders would have to be bolted to the side frames. Inasmuch as we had decided on a steel brake, it was natural to resort to welding in numerous places. The end plates for the top and bottom girders were welded to the longitudinal members and quite a few pads were welded on the vertical frames to take necessary planer work. This welding presented no difficulty whatever as we were fairly well supplied with welding equipment and shielded arc electrodes for mild steel. Of course, the amount of welding at each place had to be very carefully considered.

"The machine work presented no great difficulties even in our machine shop. One of the mechanical problems to which we had to give very considerable attention was the boring of the four bearings for the main eccentrics. These four bearings simply had to be in perfect alignment. We decided that we would bore these with a portable boring bar mounted on temporary bearings on the outsides of the two main frames. At first it seemed that we would have to partly build proper equipment to turn and feed this boring bar. Fortunately, however, we had purchased a few months previous a radial drill press which proved to be a truly universal machine. By swinging the arm of this press so that the shaft was in a horizontal position we readily connected it to the boring bar through two universal joints and so very readily bored the four holes in true alignment.

"All of the principal bearings in the press were made from hard bronze and these were very carefully scraped in the assembly of the machine.

"While this brake was being built an engineer from one of the larger builders of this same equipment visited our office and, in fact, went over our plans. He stated that we could very safely put 300 tons on the press rather than the 250 tons which we had estimated in our conservative design. He made two suggestions which were incorporated:

"One of these suggestions was the two counterbalancing air cylinders which were practically all the cast iron used in the entire job.

"The brake was finished in due time, the final assembly being on the concrete foundation which had been previously poured, and we now have been running the machine for several months, and it does just as good work as a far more expensive machine which we could have purchased but which we could not have put into operation as soon as the machine which we had built.

"The other suggestion pertained to the braking mechanism which is absolutely necessary in order that the downward travel of the ram may be accurately controlled. The first brake simply would not stop the coasting of the machine, but a new design was made one night and put on the next day. It worked perfectly. In fact, the ram may now be moved upward or downward in very low fractions of an inch in order that the bending may be controlled as is worked in such a machine. We may state that the actual operation of the machine has improved in this respect. At first there was a slight grabbing action in the clutch but within a few days this smoothed itself out.

"It may be of interest to know that, not counting overhead expense, we actually saved something like $5000 by building this machine ourselves. Some of this extra expense was saved because of the heavy unloading expenses which would have been involved had we bought a machine manufactured elsewhere. This unloading of a machine, weighing about 35 tons and being rather top heavy, would have cost approximately $500 and such work is considered rather a dangerous undertaking. Building a machine on its own foundation saved the greater part of this expense."

The over-all size of the base of the machine is 6 by 11 ft., the upper structure measuring 9 by 17 ft. with a height of 14 ft. Sizes of various members used in the welded design were as follows: end plates, 54 by 4 in.; ram, 48 by $3^1/_2$ in.; bottom girder, 2 plates of 33 by 2 in. and 2 plates, 35 by $1^3/_4$ in.; top girder, 2 plates, 15 by 2 in. with $^3/_8$-in. web plates, top and bottom.

Unit stresses used in the steel parts were taken at a rather low value of 3000 to 4000 psi. in order to minimize springing and other possible distortion in the machine.

The air cylinders at the top of the structure (visible in Figs. 1 and 2), serve a dual purpose. They counterbalance the weight of the ram and relieve the

Fig. 2—End and Side View of Welded Machine Showing Air Cylinders at Top

McKAY E-973

a new specialized

WELDING ELECTRODE

FOR WELDING HIGH CARBON and HIGH MANGANESE STEELS

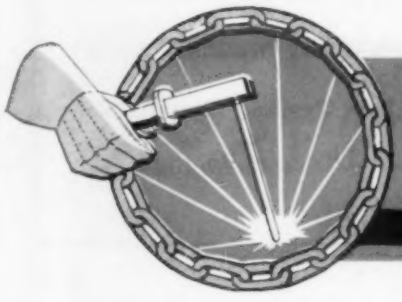
Now you can have a *better* welding electrode . . . one that *lasts longer* and is *easier to apply* . . . for building up or otherwise welding high carbon and/or high manganese steels!

McKAY E-973 is specially made for the job. The weld metal will not cross check or crack under the deposit. Although soft in the "as welded" state, it work hardens rapidly . . . permitting heavy pads to be built up without danger of mushing down, cracking loose, spalling or flaking when subjected to constant wear and service. Exceptionally smooth flowing properties make it unusually easy to apply. It does not require pre-heating or frequent delay for peening.

McKAY E-973 is the result of intensive research and service testing. It was specially developed for railway use but has wide application in other industries where welding of comparable steel is involved . . . effective demonstration of the McKAY policy of manufacturing electrodes to meet *specific needs.*

Write today for full information.

General Sales Office: York, Pa.



THE McKAY COMPANY
PITTSBURGH, PA.

WELDING ELECTRODES . . . COMMERCIAL CHAINS . . . TIRE CHAINS

shock, especially when the machine is used for punching. A small tank at the rear of the unit is directly connected to the two cylinders and maintains a constant pressure of about 60 psi. This pressure may be increased to approximately 100 psi. to further cushion the shock on some heavy operations as in cases where the punch pierces the material.

One of the interesting features of this arc-welded press brake is the accurate clutch control of the ram. For example, if bending is to be done (as is frequently the case) to a line marked on the plate rather than by gaging, it is necessary to "inch" the ram down until the die almost touches the plate and adjust the plates so that the mark is directly under the die.

Most bending dies, both male and female, are made for bending 90°. Of course, special dies are frequently planed out for producing special angles when quantity justifies. However, when a plate is to be bent at less than 90°, the operator feels his way by setting the ram height as near as possible but checking the bevel until he gets the right bend.

In bending large plates with the flange near one edge the long projecting end of the plate has to go up as the ram comes down. Aside from being dangerous to the operator and helpers, if this plate is suddenly bent, the inertia would cause a backward bend in the long end of the plate.

In order to utilize the available planers, the frame of the machine was constructed in four principal parts consisting of the end frames, bottom girder, top girder and ram. Pads were welded on the end plates for joining various girders, main bearings and ram, and all pads were planed off at one setting to assure plumbness.

The inside plates of the bottom ram were welded together with fillers and preplaned plates were then fused by welding to the girder for bolting to corresponding parts on the end frames. To prevent distortion, all welding on these plates was done after the frame had been bolted together.

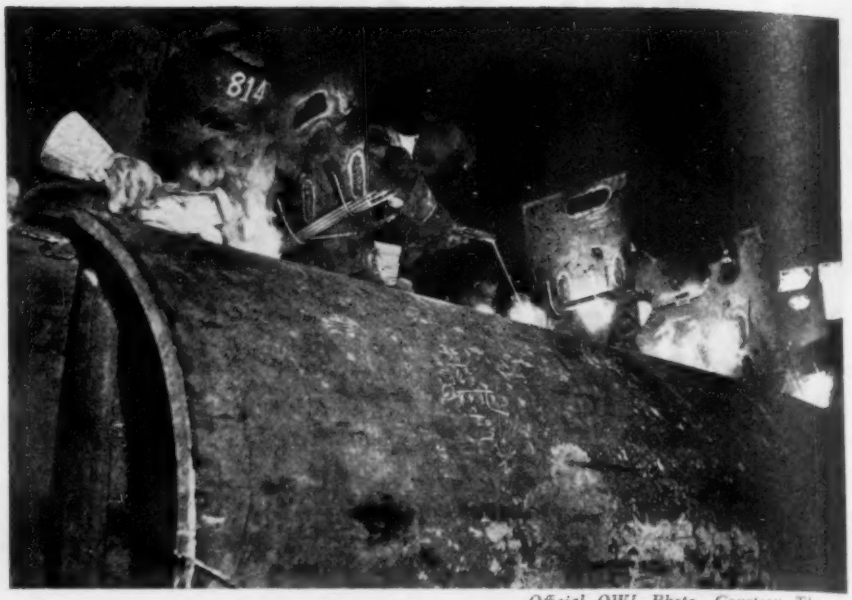
The top girder was completely welded with top and bottom web plates after which the ends of the girders were turned off in a lathe to insure accuracy of length and to make the ends parallel. This method was resorted to due to the lack of available equipment for facing off the ends.

Stresses for the welded joints were carefully calculated in accordance with standard welded machine design. In general, the electrodes used were of AMERICAN WELDING SOCIETY specification E-6012, in $^1/_4$- and $^5/_{16}$-in. sizes. For the principal joints, multiple-pass technique was used, each bead being peened when necessary and the weld metal cleaned with a wire brush before laying each successive bead.

Although the press brake was conservatively designed for a 250-ton capacity, machine fabricating engineers have estimated that the design is equivalent to similar units of 300-ton capacity.

YEAR BOOK ERROR

The Company connection of William G. DeGray (C) was erroneously given in the Year Book. It should be as follows: Welding Engineer, The Pfaudler Co., Rochester 4, N. Y.



Official OWI Photo. Courtesy The Lincoln Electric Co., Cleveland, Ohio

HIGH-PRESSURE WELDMANSHIP

Indicative of the Widespread Use of Arc Welding for a Large Proportion of Today's Power-House Equipment, These Arc Welders Are Fabricating a High-Pressure Boiler in the Large Chattanooga Shops of Combustion Engineering Co. for a TVA Hydroelectric Installation.

Employment Service Bulletin

POSITION VACANT

V-144. Age: 25 to 40. With a technical education in metallurgy, mechanical engineering or chemistry with a knowledge of welding. Should be a native of Canada and able to speak French, since the work would involve considerable traveling in the province of Quebec. Headquarters would be Niagara Falls, Ontario. Duties would be to first learn how to apply different welding rods and electrodes, both the oxyacetylene and electric, and then supervise the coating and testing of such electrodes and eventually progress to the field where he would make sales contacts and perform welding demonstrations.

SERVICES AVAILABLE

A-473. Welding Supervisor with 12 years' experience in the welding field. Experience includes operation as electric and gas welder, Atomic and Unionmelt. Ability to set up production work and handle men. Considerable fabrication experience.

A-474. Welding Production Manager. 30 years' welding experience. Labor control systems will positively increase production in any welded *shipyard*. Capable of assuming complete responsibility of all types of welding and burning. Also all subordinating divisions such as purchasing, training equipment, welding engineering and accounting. Will be available May 1st.

A-475. Welding Development Engineer—seasoned executive, married, 4F. Complete metallurgical, chemical, electrical and mechanical knowledge, pertaining to welding. Broad experience, electrode and apparatus development, research and sales, welding fabrication and process engineering, manual and automatic applications. Mild and alloy steels, nonferrous metals. Desire placement where background and contacts may be fully utilized.

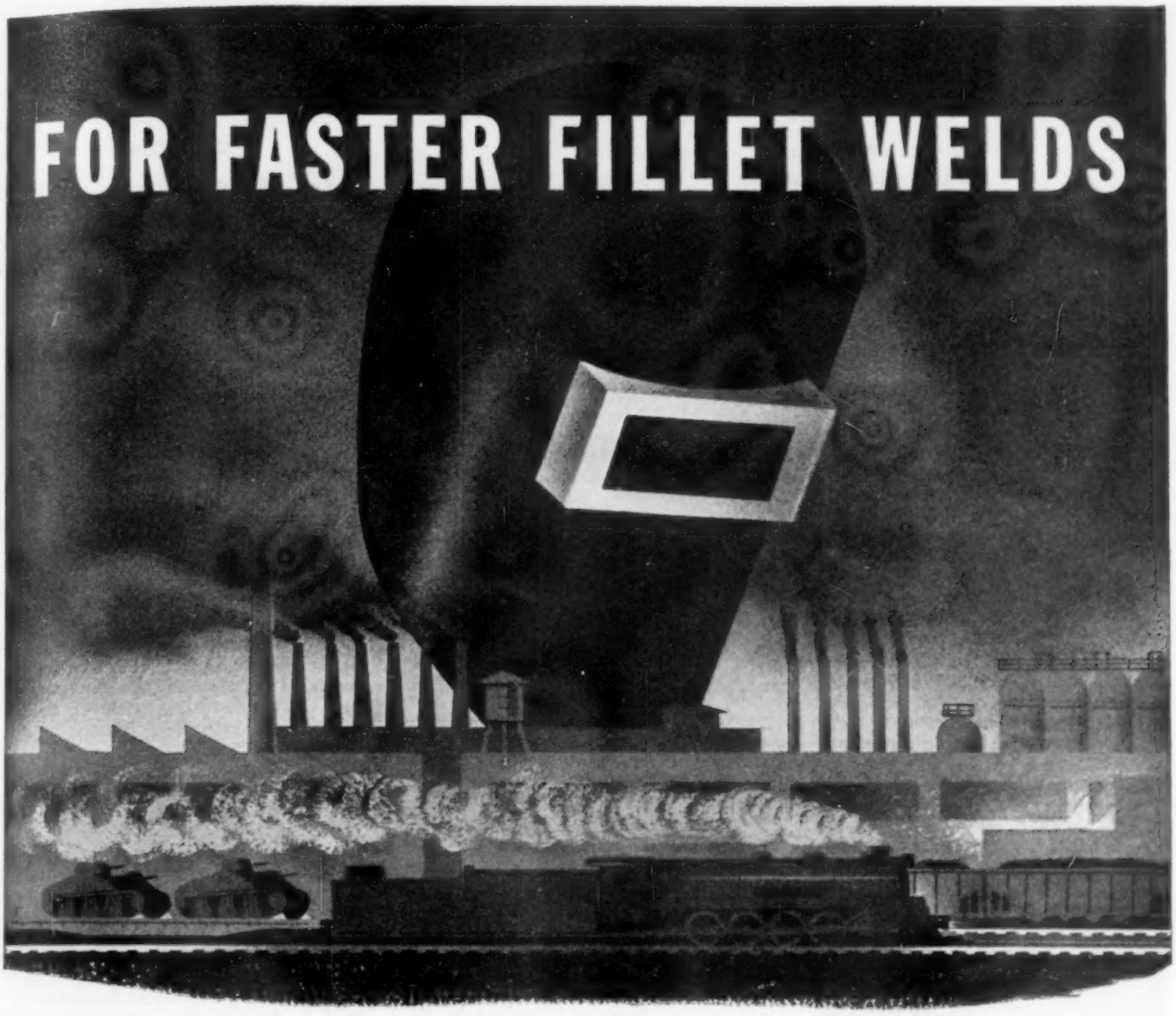
A-476. Thoroughly experienced Combination Welder, Instructor and Supervisor. 18 years' experience in processes, teaching, fabrication, maintenance and job shop welding. A specialist in extra heavy Oxyacetylene welding, involving preheating. Have successfully supervised and welded castings weighing upward of 45 tons, also machine bases, shovel booms, crusher cones and spiders. No objection to travel or overseas contract. Prefer connection with concern where opportunity exists together with a definite postwar position. Married, 40 years of age. Available immediately.

Annual Meeting

AMERICAN WELDING SOCIETY

Hotel Cleveland, Cleveland, Ohio

Oct. 16-19, 1944



Use Raco 20 Shielded-Arc Electrodes

High-quality deep penetration single-pass fillet welds, and more of them per hour, are assured when you use Raco 20 Shielded-Arc Electrodes. And with these electrodes you can obtain the same top-grade production whether you employ direct current straight polarity or reverse, or alternating current.

The advantages of Raco 20 Shielded Electrodes are of greater importance now than ever before. We shall be glad to send you samples so you may test their outstanding performance. Just write

Raco 20 Conforms with the following specifications: A.W.S.—A.S.T.M. Specification A233-42T, Type E-6020. U. S. Bureau of Ships Specification 46E3 (INT) Grade II Class 2.

The **REID-AVERY COMPANY**

DUNDALK BALTIMORE 22 MARYLAND

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

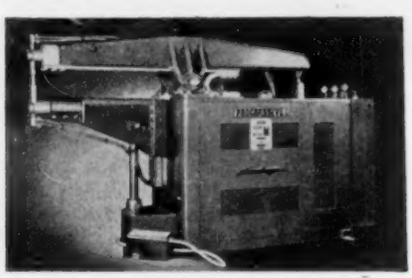
SPOT WELDER FOR STRUCTURAL SECTIONS

A rocket arm welder capable of handling in continuous production the spot welding for aircraft and other types of equipment of "structural" aluminum sections up to $^1/_8$th in. Alclad has been announced by Progressive Welder Company, 3050 E. Outer Drive, Detroit 12, Michigan.

The new Model "C" welder is a larger companion model to the Model "B" standard rocker arm welder recently announced by the company for welding Alclad up to 0.081-St.

Designed for a conservative production rate of 1000 to 2000 spots per hr. when welding heavy sections, the model "C" is notable for the extreme rigidity of its construction. While the welder is rated at a maximum point pressure of 6500 lb. (at 90 lb. factory air line) deflections even under such conditions are held to a minimum, it is stated.

In the rocker arm design, the practice so successful in the Model "B" of throwing all deflections into the vertical plane has been followed also on the Model "C." As a result these deflections can be used to improve the weld by providing a "spring follow-up" during the weld.



The welder will handle fairly large size work, throat depth being adjustable from 36 to 42 in., and throat opening from $7^1/_2$ to $17^1/_2$ in. In addition to the normal 1 in. working stroke of the rocker arm, the latter is also provided with a retracting stroke which provides a $4^1/_2$-in. clearance between points to permit insertion of flanged work. This retracting stroke is controlled through one of the dual shrouded foot switches provided with the machine.

Controls are provided for three different pressure conditions. Normal welding pressure is applied by depressing the foot switch. Forging pressure is applied automatically. To apply light pressure for tip dressing a toggle switch is thrown on the machine and the foot switch is depressed as for welding.

Upper and lower arms are designed to handle standard electrodes and holders, although refrigerated welding points may also be used if desired. Electrodes may be mounted either vertically or at a $22^1/_2°$ angle. The latter position is not recommended however if the machine is to be operated at around its maximum pressure.

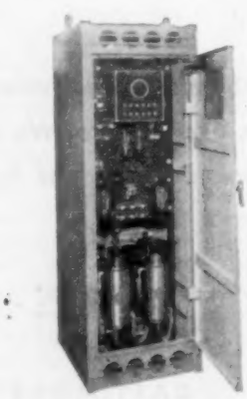
Transformers are of the pancake type with 600 turns, while a four position tap switch enables the selection of various turn ratios. Provision is made on the front of the base of the machine for mounting of the control panel furnished by the manufacturers of the capacitor discharge unit. Floor space of the base is 35 by 66 in. while over-all height is only a little over five feet, giving a clear view over the top of the machine despite its large capacity.

SEAM WELDING CONTROL

A new control designed exclusively for seam welding, and incorporating a completely electronic timing circuit, has been announced by the Industrial Control Division of the General Electric Co. Designated as Type CR7503-B110, the new resistance welding control is especially suitable for operations where frequent changes of the timing pattern are required, such as when welding a variety of materials of various shapes and thicknesses.

Operating on a 230/460/575-v., single-phase, 60-cycle power supply, the control consists of a timing panel, a firing and a heat control panel, and a power panel, any one of which can be separately disconnected and removed to facilitate inspection or servicing. An electronic circuit, incorporated in the control, provides accuracy of the timing pattern of the weld without utilizing moving parts and regardless of normal, instantaneous or gradual line-voltage variation. Smooth heat control is provided by the phase-shift method.

All tubes and connection terminals are conveniently located, the water supply inlet and outlet fittings are on the outside of the enclosure, and a row of indicating lights on the front door show instantly whether (1) the water flow is adequate, (2) power has been applied and (3) the time-delay has timed out.

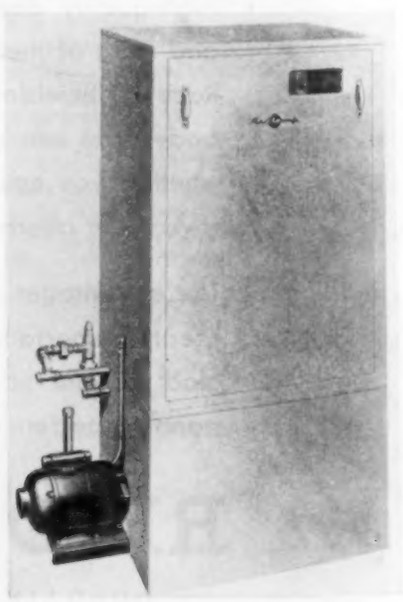


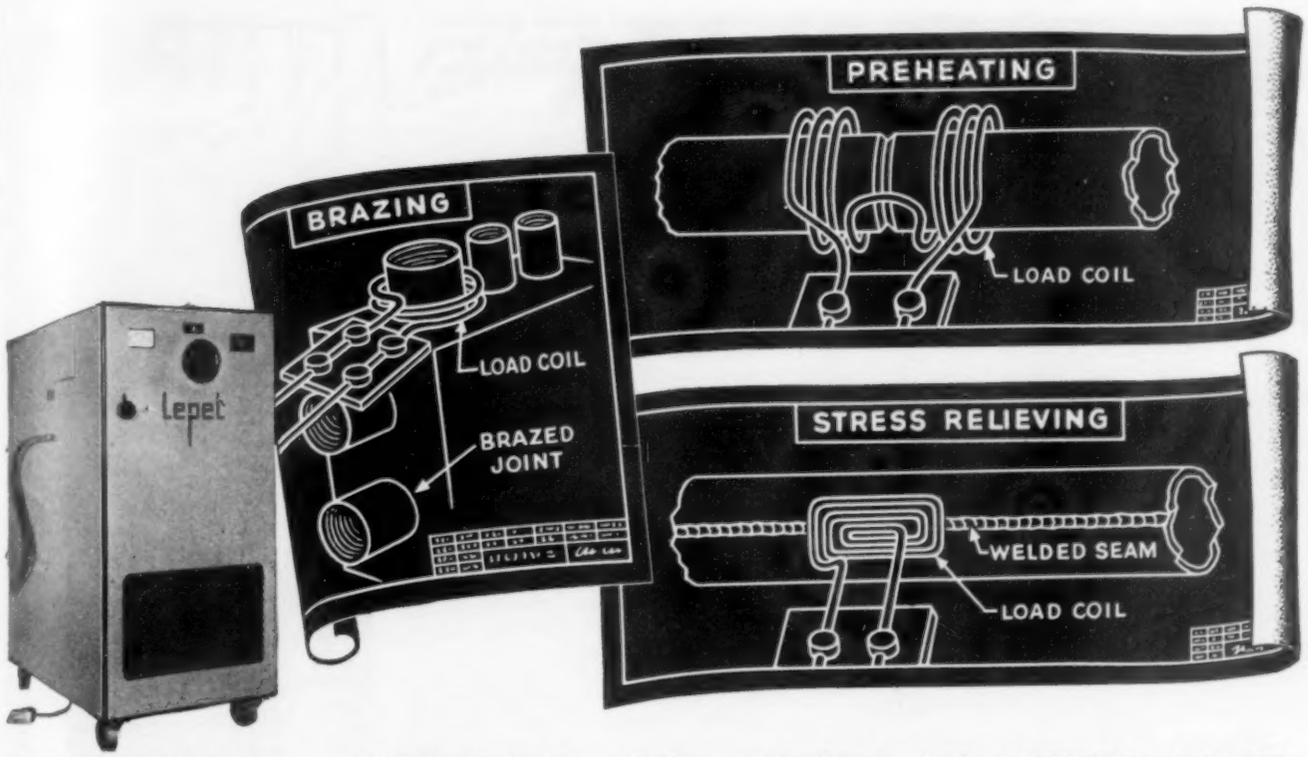
ELECTRODES

The Anthony Carlin Co., Cleveland, Ohio, has announced four recent additions to its line of "Perfection" welding electrodes. Grade P-61 is a shielded arc, general purpose, straight polarity d.-c. electrode for welding mild steel in all positions. It is designed especially for fast production where high currents are used and the arc action is strong, and it meets the requirements of A.W.S. Classification E6012. P-103 is a shielded arc a.-c. electrode suitable for all-position welding. It meets the requirements of A.W.S. Classification E6011 and A.S.M.E. Par. U-68. This electrode is also suitable for welding the low-alloy, high-strength steels when these steels are used primarily for their high-strength properties. P-170 and P-180 are bare and wash coated electrodes meeting the requirements of A.W.S. Classifications E4510 and E4511, respectively. These are straight polarity d.-c. electrodes which have a broad field of application where the physical properties indicated in the specifications are acceptable. A revised catalog recently issued by the company contains full descriptions of all of these new grades.

COOLING SPOT WELDING TIPS

An air-cooled "packaged" $1^1/_2$-hp. refrigeration unit, designed for cooling resistance spot welding tips and for other specialized industrial liquid cooling service, has been announced by Airtemp Division, Chrysler Corp., according to Paul B. Zimmerman, vice-president and general sales manager. The packaged resistance welder cooling unit is completely self-contained, and is equipped with the Airtemp hermetically sealed radial compressor.





One compact, portable Lepel Unit performs all hardening, stress-relieving, soldering, brazing and melting operations. Readily convertible to peace-time production at no expense.

INCREASED PRODUCTION AT LOWER COST

with High Frequency Induction Heating for Pre-Heating, Stress-Relieving, Metal Joining

Lepel Induction Heating produces heat up to any selected temperature exactly where it is required for the proper period of time necessary to produce the desired results. It is astonishingly speedy in operation, reducing heating time from minutes to seconds, yet it works with a degree of accuracy and efficiency rarely obtainable by other methods.

Pre-Heating, Stress-Relieving

Lepel Induction Heating is used by many leading industrial plants for pre-heating before welding or stress-relieving welded seams. In such applications, it affords remarkable economies in time and cost with further advantages of uniformity and heat-concentration which prevents structural changes in sections of the metal outside the field of the load coil. In many instances, heating can be performed as a continuous operation, further reducing time cycles and costs.

Metal Joining

Lepel Induction Heating also quickly and neatly performs the most intricate brazing and soldering operations on all ferrous and non-ferrous metals, using brazing alloys from lowest to highest melting points. By pre-fluxing and pre-placing of the alloy in the form of rings, strips, or irregular shapes, many complicated production brazing jobs are reduced to quick, simple operations which can be performed by any unskilled worker. May be operated manually or fully automatic.

Consider the possibilities of Lepel Induction Heating applied to your present and post-war production. Lepel engineers will gladly aid you in working out the details of the application.

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LEPEL HIGH FREQUENCY LABORATORIES, INC.

PIONEERS IN INDUCTION HEATING

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HIGH FREQUENCY INDUCTION HEATING UNITS

Tip cooling of spot welders makes it possible not only to increase the welding speed, but also reduces the amount of tip cleaning and dressing necessary in the average welding operation. When a continuous number of welds are made the tip temperature tends to get hotter, and hotter, and for this reason ample capacity is necessary in the refrigerating mechanism, to keep the tips at the desired temperature, Mr. Zimmerman asserts.

The Chrysler Airtemp packaged resistance welder cooling unit has a counter flow liquid cooler mounted in the base. An insulated storage tank is equipped with a special 3/4 hp. pump having a nominal capacity of 6 g.p.m. Location of the liquid cooling unit in the base eliminates losses of the coolant employed at the time of changing tips, as all liquid drains back to the storage tank. A pressure-regulating valve assures flow of coolant at a constant pressure.

The unit is equipped with high-pressure cutout; a remote bulb thermostat, having a temperature range from minus 20° to plus 20° F., controls the temperature of the coolant.

SALVAGING ALUMINUM CASTINGS

The Metallizing Company of America, 1330 W. Congress St., Chicago, introduced a new unit at the meeting of the American Foundry Association in Buffalo, New York, April 25th to 28th.

L. E. Kunkler, president, stated that with this new unit it will now be possible to effectively repair and salvage defective aluminum castings by cold welding without setting up stresses or crystallization caused by high temperatures.

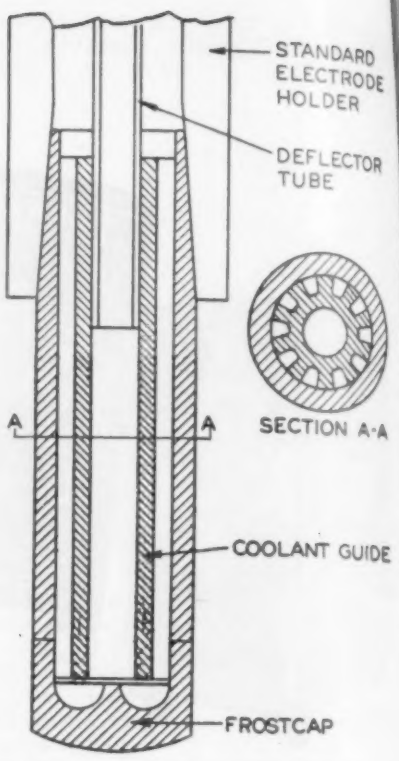
It will also be possible to obtain positive fill-ins on all aluminum castings so that they will pass critical X-ray examinations and show absolutely no lines of demarcation after machine fiuishing.

It is further stated that at no time does the work get over 100° F., eliminating any possibility of stresses.

In addition to widespread foundry applications, machine shops will find important uses filling blowholes or cracks which can be repaired while the work is still in the lathe.

SELF-ADAPTING FROSTPOINT

A self-adapting "Frostpoint" spot-welding electrode for use with standard electrode holders, eliminating the need for adaptors, is announced by Frostrode Products, 19003 John R, Detroit 3, U.S.A. Previously, adaptors were required to separate the cooling refrigerant in the "Frostpoint" from the water circulation in the electrode holder for welding in the 0° F. range. While this design still provides maximum efficiency for "zero welding" the widespread use of "Frostpoints" for spot-welding operations even above the zero range led to the development of a simplified design. While retaining the controlled coolant flow, increased cooling surfaces, replaceable finned cap and other features of the standard "Frost-



point," the new electrode provides complete interchangeability with conventional electrodes.

The new self-adapting electrode, though intended primarily for use with refrigerated

23 Foot Weldment BY UNITED

This huge drill base demonstrates the ability of United Welding Co. to handle large, heavy or difficult assignments.

It will be to your advantage to weld as much of your post-war product as possible . . . to make it stronger, yet lighter, and modern in appearance. Look upon United as the logical plant to fabricate all or certain of the parts for that product. Feel free to consult United engineers on designs. Have them quote you. (Send for the United Machine Tool Bulletin.)

Also specialists on paper making equipment—beater rolls, dryer stacks, settling tanks, etc. Get United's Paper Mill Bulletin.

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WELDING FABRICATORS OF MODERN DESIGNS

Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them
The Trade-Name is "ANTI-BORAX"

Ask for Them *Unequalled for Quality*

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; No. 16 Silver Solder Paste Flux.

ANTI-BORAX COMPOUND COMPANY
Fort Wayne, Indiana

Time Counts—
Gas cut and Weld with
Shawinigan Carbide

SHAWINIGAN
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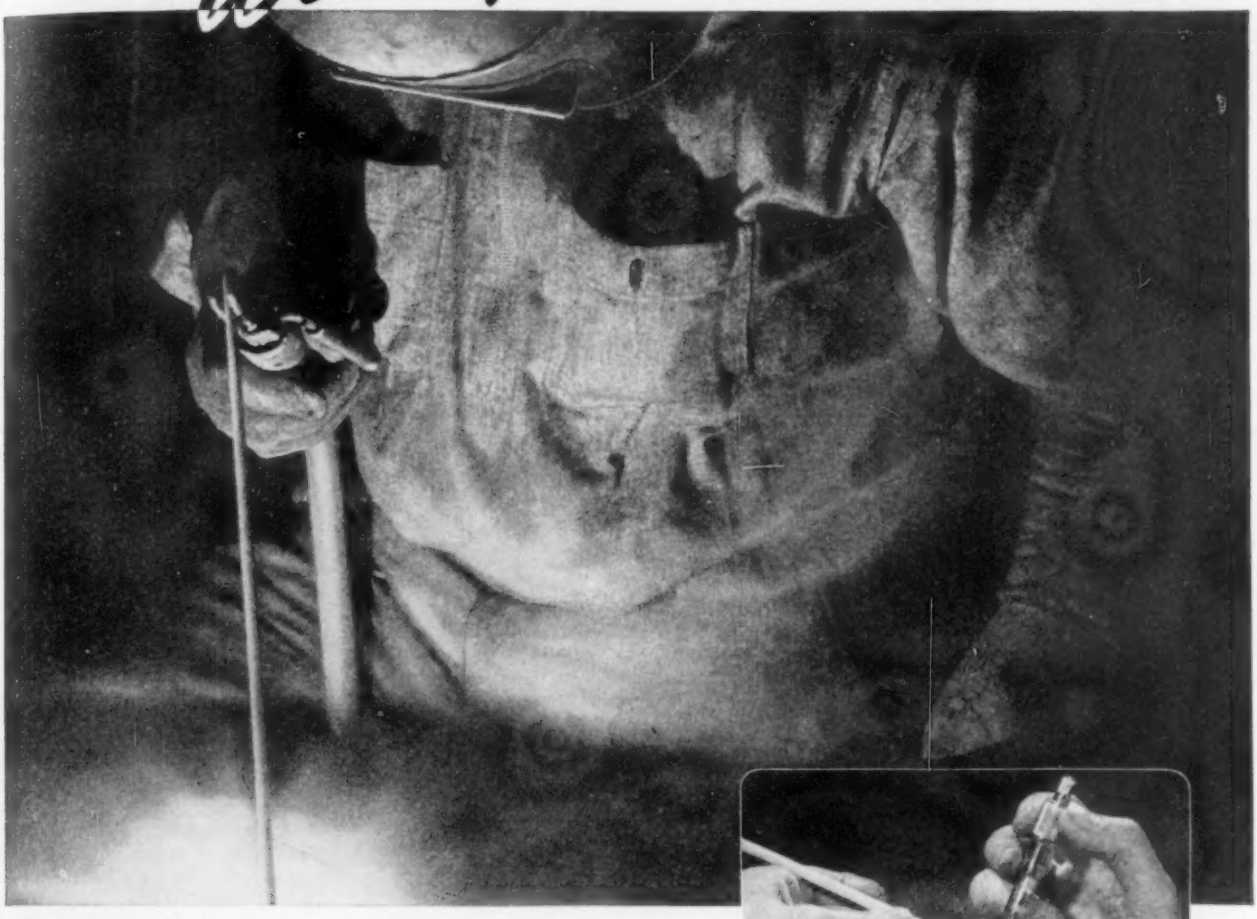
EMPIRE STATE BUILDING, NEW YORK 1, N.Y.

PAGE *Welding* ELECTRODES



PAGE HI-TENSILE "C" ELECTRODES

• You can depend upon these wires for uniformly good results in horizontal, vertical and overhead welds—welds that pass the most rigid tests for tensile strength, elongation, impact and fatigue resistance. X-Ray examinations will prove the evenness of weld metal and absence of included gases and slag.

Ask your local **PAGE** Distributor for specific information about any type of welding electrodes.

STAINLESS . . .

Your **PAGE** Distributor offers you a complete range of electrodes for welding Stainless Steel. The uniform coating on **PAGE-*Allegheny* STAINLESS STEEL ELECTRODES** is heavy enough to shield against oxidation —to provide the protection of easily-removed slag (permitting longer cooling time)—to eliminate surface checking and to hold spatter loss to a minimum.

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ESSENTIAL PRODUCTS...TRU-LAY Aircraft, Automotive, and Industrial Controls, TRU-LOC Aircraft Terminals, AMERICAN CABLE Wire Rope, TRU-STOP Brakes, AMERICAN Chain, WEED Tire Chains, ACCO Malleable Castings, CAMPBELL Cutting Machines, FORD Hoists, Trolleys, HAZARD Wire Rope, MANLEY Auto Service Equipment, MARYLAND Bolts and Nuts, OWEN Springs, PAGE Fence, Shaped Wire, Welding Wire, READING-PRATT & CADY Valves, READING Steel Castings, WRIGHT Hoists, Cranes . . . *In Business for Your Safety*

coolants, also provides better cooling with ordinary water cooling than does the conventional spot-welding electrode, it is claimed. Use of "Frostpoints" in place of conventional electrodes, without any other change, results in an immediate reduction of electrode temperature during welding equal to the use of 60° F. colder water, it is reported.

Elimination of adaptors is especially desirable when welding in those places where clearances for the electrodes are "close," such as adjacent to flanges, overhangs, in channels, etc. The new electrode eliminates interference from coolant lines in such operations.

ELEVATING TURN TABLE

The Lyon-Raymond Corp., 1475 Madison St., Greene, N. Y., recently were called upon by one of their customers to develop this special piece of equipment for automatically feeding processed parts to a pickling bath.

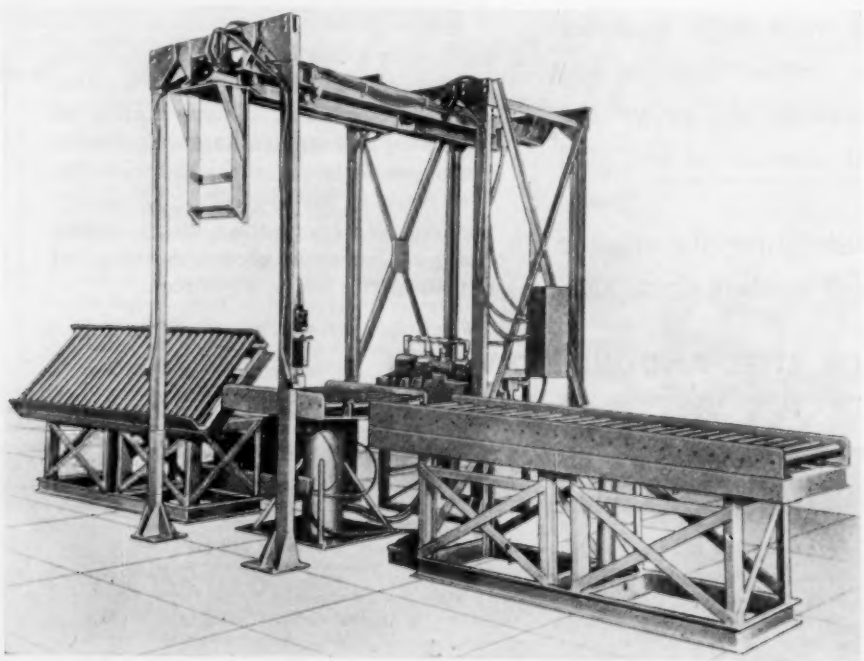
In this operation a large, empty, wire basket is placed on the tilting conveyor table as shown in the left-hand view of the illustration. This table is tilted to place the basket in a more convenient position for loading. The table is then hydraulically lowered to its horizontal position and the basket of parts rolled onto the elevating table.

The operator then presses an electric push button which starts a sequence of the following operations, all of which are automatic until the table returns to its original lowered position.

The table elevates hydraulically 38 in. and during its elevation turns 90°. Upon reaching its full elevated height, it automatically starts a pusher (the end of which is shown between the two front uprights) which travels across the table and pushes the basket off the table onto another roller conveyor (not shown in the illustration). The basket is then pushed into the pickling bath. The pusher returns to its original position and the table lowers and turns 90° back to its starting position.

During this sequence of operations the operator on the right side of the elevating table has tilted his table hydraulically, loaded his basket, lowered it hydraulically to its horizontal position and is ready to push the basket onto the elevating table as soon as it reaches its lowered position.

The elevating and turning of the table, the pusher operation and the return of both to their original positions, is all automatically accomplished in thirty seconds. These operations are obtained hydraulically, controlled by limit switches and solenoid-operated hydraulic valves. The only manual operation of this sequence is pushing the starter button at the beginning of the cycle. The table is of welded construction.



NEW WILSON COATED ALUMINUM-BRONZE ELECTRODE NO. 200

The Wilson Welder and Metals Co. announces a new coated aluminum-bronze electrode—Wilson No. 200. This new, coated high-tensile bronze electrode is a shielded arc electrode, and can also be used as a filler rod in carbon arc welding. It will produce welding deposits of great strength and hot ductility, combined with desirable resistance to corrosion.

Deposits made with this electrode are superior to standard manganese bronze with respect to corrosion resistance, and are equal to it in strength, hardness and ductility.

The Wilson No. 200 has a most universal application in the welding of most bronzes, malleable and cast iron or steel. In addition, it has other specific applications for which it is especially suited, such as welding manganese bronze conforming to Federal Specifications QQ-B-726b, or Navy Specifications 49-B-3e for marine propellers and other parts where great strength, ductility and corrosion resistance are strict requirements.

The electrode can also be used for welding dissimilar metals, such as cast iron to brass, steel to malleable iron, or the joining of any two metals which are weldable with aluminum-bronze.

Sizes from $^1/_8$ to $^3/_{16}$ in. in 14-in. lengths and $^1/_4$ in. in 18-in. lengths are standard stock items. Sizes from $^5/_{16}$ to $^1/_2$-in. in 18 in. lengths may be procured on special order.

The new Wilson No. 200 Coated Aluminum-Bronze Electrode is available through offices of the Wilson Welder and Metals Co. and their authorized distributors.

PREPARES ALUMINUM SURFACES FOR SPOT WELDING

A new method for rendering aluminum surfaces chemically and metallurgically clean in preparation for spot welding, is announced by Turco Products, Inc., of Los Angeles and Chicago. Turco Vulco-Etch is a chemical bath which frees aluminum alloy surfaces of oxides, corrosive salts, and tenacious grease and oil films.

Consistent, strong spot welds cannot be obtained if the aluminum surface is oxidized, oily or contaminated with corrosive salts. When the surface in contact with the electrode is not perfectly clean, resistance of the metal to the flow of electrical current is increased. The resultant excessively high temperatures may be responsible for cracked welds, blowholes and other irregularities. Further, surface impurities in the electrode area tend to become fused into the weld. These impurities cause unsymmetrical weld contours and weaken the weld by reducing tensile strength, the elasticity, and the fatigue resistance of the metal.

Vulco-Etch lays the foundation for sound spot welding by assuring a chemically and metallurgically clean surface. Cleaning and etching are accomplished in a 5- to 20-min. dip in the Vulco-Etch solution. Unheated wood-lined, rubber-lined or crockery tanks are used. The material rinses freely in fresh, cool-running water. The Vulco-Etch solution is long lived, and may be used for months without change.

AIR CONDITIONING IN ELECTRODE MANUFACTURE

Air conditioning has increased the quantity and quality of stainless steel welding electrodes produced by the Paschall plant of the Arcos Corp., Philadelphia, Pa. The company makes arc-welding electrodes for electric welding—an item whose essentiality is too well known to need comment.

Qualitatively, production with conditioned air also scores higher than previously, according to the Arcos report. Rejects are down, because the system—specially designed by Carrier Corporation engineers—provides uniform air velocity and constant conditions during manufacture. Speedy drying of the four coatings on the electrode keeps it from cracking on subsequent operations.

ALMOST RIGHT
IS WRONG
SMITHway
Electrodes
in Action
All-welded Diesel engine bases produced in quantity by A. O. Smith for our powerful two-ocean Navy.

WHEN you are up against the "buzz saw" of important service, you want electrodes that have been proved practical by shop experience—backed up, of course, by sound research and engineering.

SMITHway Certified Welding Electrodes are reliable *production tools*, thoroughly proved by day-to-day application in our own shops. With us "Almost right is *wrong*." We must have dependable *quality*, dependable *uniformity*, and the right *operating characteristics* in the electrodes we use. "Almost right" is not good enough. That's why we make the welding electrodes used in our own plants.

Since there isn't any kind of arc welding we don't do, and since there are many kinds of arc welding done only in our shops, SMITHway Certified Welding Electrodes are *proved* in every type of arc welding operation. That, we believe, assures *better welding results* in your shop. We know it does in ours.

Mild Steel . . . High Tensile . . . and Stainless Steel
WELDING ELECTRODES

made by welders . . . for welders

SMITHway A. C. Welding Machine saves power; eliminates arc blow.

SMITHway Welding Monitor trains better welders faster.

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SECTION ACTIVITIES

CHICAGO

E. V. David, Assistant Manager of Applied Engineering Department, Air Reduction Sales Co. was the guest speaker at the March 17th meeting of the AMERICAN WELDING SOCIETY. Mr. David chose as his subject "Heavy Oxyacetylene Cutting." In an interesting, well illustrated talk Mr. David presented a brief review of oxyacetylene cutting methods and brought the Section up-to-date in this modern method of severing steel. Interesting pictures and discussions described and illustrated the various applications that were being made of oxyacetylene flame cutting in particularly heavy materials. A portion of his talk was devoted to an extremely interesting use of oxyacetylene cutting that has been made in the form of crank shafts for Liberty ships. In this application flame cutting has replaced heavy forging operations.

Mr. David also outlined some of the plans for forthcoming convention for the AMERICAN WELDING SOCIETY to be held in Cleveland.

Resistance welding, automatic welding and oxyacetylene applications were discussed before capacity crowds at the three welding panels of the Chicago War Production Conference. The Conference was held at the Hotel Stevens, March 30th, under sponsorship of the Chicago Technical Societies Council, and the welding meetings were held under the direction of the Chicago Section of the AMERICAN WELDING SOCIETY. Jim Quigley, Welding Supervisor, Graver Tank and Manufacturing Co. acted as general chairman of the welding sessions.

The Resistance Welding Panel, under the chairmanship of C. L. Pfeiffer, Electrical Engineer, Western Electric Co., opened with a movie, "Aircraft Welding," produced by the United States Navy to picture the various ways in which resistance welding is today being used in the manufacture of military aircraft. Various technical aspects of resistance welding were brought out in the panel discussion which followed the film. The panel consisted of A. M. Unger, Assistant to Supt. Shipbuilding Div., Pullman-Standard Car Mfg. Co.; W. B. Frackelton, District Industrial Electronics Specialist, General Electric Co.; C. W. Dodge, Engineer, Sciaky Bros.; Clyde G. Bassler, District Manager, The Taylor-Winfield Corp.; and J. M. Cooper, Sales Engineer, National Electric Welding Machines Co. There were no formal speeches, the entire program being devoted to the answering of questions from the floor.

It was brought out that satisfactory spot welding of aluminum is possible only because of the development of satisfactory electronic controls and stored energy spot welders, that is, spot welders which are capable of building up a reserve of electrical energy by drawing current from the line continuously rather than only during the welding period as is the practice of the conventionally designed welder.

The diversified uses of flash welding were also discussed. Flash welding makes possible long continuous strips and sheets in our steel and tin mills. Flash welding makes it possible to form auto bodies from many pieces of steel so that they become an intricate unit. Flash welding provides a quick and effective means of joining tubes to tubes or tubes to castings and forgings, in the manufacture of component parts of aircraft. In all of these seemingly impossible applications flash welding saves considerable time.

Two welding sessions were held in the afternoon, one at 2 P.M. on automatic welding and one at 4 P.M. on the oxyacetylene process. The Automatic Welding Session was under the chairmanship of H. M. Downing, Service Engineer, Lincoln Electric Co., while the other speakers were Ed. Morris, Mgr., Unionment Service, The Linde Air Products Co.; L. G. Pickhaver, Welding Engineer, General Electric Co.; L. S. McPhee, Welding Supervisor, Whiting Corp; and Jim Quigley, Welding Supervisor, Graver Tank & Mfg. Co. These speakers discussed the various automatic welding processes, including submerged melt and atomic hydrogen. Mr. McPhee covered the automatic welding of structural members and Mr. Quigley the automatic welding of pressure vessesl. A cost comparison of automatic vs. manual welding was given by Mr. Downing.

Some of the latest applications of flame-cutting, flame-gouging and flame-beveling were shown on slides presented at the 4 P.M. session by F. McGuire, Jr., Division Service Engineer, The Linde Air Products Co., Inc. Slides showing flame-hardening applications to various war products were shown by Walter Handrock in behalf of Stephen Smith, Air Reduction Sales Co., who was unable to attend.

The formal part of the last meeting closed with a discussion by R. D. Wasserman, President, Eutectic Welding Alloys, Inc., on low-temperature welding, brazing and soldering. As in the other sessions, questions and answers followed. This meeting was under the capable chairmanship of L. S. McPhee, Welding Supervisor Whiting Corp.

Other members of the AMERICAN WELDING SOCIETY taking part in the War Production Conference included E. R. Seabloom who was Co-Chairman of the Panels Committee and R. L. Kohlbry who was Chairman of the Exhibits Committee. Mr. Seabloom was Chairman of the Chicago Section of the AMERICAN WELDING SOCIETY in 1942–43 while Mr. Kohlbry is the present Chairman of the Chicago Section.

CINCINNATI

A joint meeting of the American Society for Metals and the AMERICAN WELDING SOCIETY Cincinnati Section was held on April 13th in the Engineering Society Headquarters. Mr. Ray P. Kells and Leonard C. Grimshaw, Chief Service Engineer and Metallurgist, respectively, at Latrobe Electrical Steel Co., presented an address on "Factors to Be Considered in Reducing Tool Failures." Mr. Grimshaw covered the selection of the correct steel for the tool, the proper design, and the heat treatment of the tool. Mr. Kells followed with a short illustrated talk on typical tool failures and how to prevent them. A motion picture on the shaping and welding of aluminum was shown at the start of the meeting.

CLEVELAND

The Cleveland Section of the AMERICAN WELDING SOCIETY has announced the Annual Welding Conference to be held at the Hotel Statler, Cleveland, on Friday, May 12th.

Three papers will be presented at the afternoon session, Ernest E. Thum, of American Society for Metals, presiding. A. G. Bissell of the Bureau of Ships, U. S. Navy will speak on "Common Sense Practices in the Use of Welding in Ship Construction and Repair." W. J. Conley, consulting engineer for The Lincoln Electric Co., will speak on "New Production Welding Techniques." Fred L. Plummer, consulting engineer for Hammond Iron Works, will speak on "Field Welded Pressure and Variable Volume Tanks for War Industries."

Following the afternoon session will be a dinner meeting, with G. N. Sieger, president of S. M. S. Corp., presiding as toastmaster. David Arnott, national president of the A.W.S. and vice-president of American Bureau of Shipping, will discuss the growing importance of welding in shipbuilding. William B. Stout, distinguished aero designer and engineer, will speak on "Research and Postwar."

COLUMBUS

Mr. R. D. Thomas, Jr., Director of Research and Engineering, Arcos Corporation, discussed Welding with Stainless Electrodes at the April 14th meeting of the Columbus Section held at the Southern Hotel.

DETROIT AND FLINT

The Flint group and the Detroit Section were privileged to have Commander O. R. Sutherland of the U. S. Navy Yard at Philadelphia talk to them at their meetings on April 6 and 7, respectively, on the subject, "The Theory and Use of

More and More

in Important Places

UNITED

MERCURY RECTIFIER and GRID CONTROL TUBES

for Resistance Welding

These features make UNITED Tubes better

1. Protruded filament, mounted on a vertical plane, increases emission area and affords greater capacity to withstand vibration and shock.
2. Greater shielding than is found in ordinary tubes permits proper thermal radiation for extended tube life.
3. Ideal relation between condensed mercury and ambient temperature is maintained.
4. Heavy duty quality is emphasized in all component parts and construction.

It is obvious, from the illustrations of these UNITED Tubes, that they are built to withstand the continuous hard uses of industrial applications in contrast to tubes designed to function under the less stringent conditions of radio communication.

TYPES ILLUSTRATED: The UNITED types illustrated will interchange with and replace other type tubes as follows:

USE UNITED TYPE	967	to replace	FG-17
" " "	972-A	" "	872-A
" " "	UX-973	" "	——
" " "	973 (Not illustrated)		873

UNITED ELECTRONICS COMPANY

Newark 2 New Jersey

Specifications to Expedite and Control Production." He presented his thoughts in a unique manner and they were stimulating and thought provoking.

The Flint group were hosts to a goodly number of Navy men from the Defoe Shipyards at Bay City and the Detroit group were privileged to have Commander R. Velz, chief of the office of Naval Inspection at Detroit, and his staff as their guests.

The report of the Election Committee shows the following officers elected for the forthcoming season: *Chairman*, Henry C. Neitzel, Whitehead & Kales Co.; *Vice-Chairman*, George J. Friebel, Harnischfeger Corp., *Second Vice-Chairman*, A. H. Lewis, Swift Electric Welder Co.; *Secretary-Treasurer*, G. N. Sieger, S-M-S Corporation; *Executive Committee*, R. Baker, M. J. Bartch, V. H. Chisholm, L. W. Clarke, H. C. Cogan, C. J. Collum, E. O. Courtemanche, G. J. Dekker, J. M. Diebold, L. A. Eckerman, M. G. Gaskin, J. E. Graham, A. J. Last, A. E. Lofquist, C. E. Phillips, M. R. Scott, Keith Sheren, G. W. Sloan, Joseph C. Smith, W. R. Stickney, E. H. Foss, R. J. Heusel.

INDIANA

Two hundred and forty key executives of Central Indiana gathered in Indianapolis March 24th, at a dinner sponsored by P. R. Mallory & Co., Inc., for the Indiana Section of the AMERICAN WELDING SOCIETY.

Guest speaker was James F. Lincoln, President of the Lincoln Electric Co., Cleveland, who spoke on "Incentives vs. Governmental Control."

The purpose of the meeting was to better acquaint industrial executives with the many advantages that welding offers in improving product quality and performance, as well as reducing costs.

Mr. Lincoln cited many revolutionary improvements that have been made possible through welding. As an example, he pointed out the case of the oil industry that has come to rely more and more on welding to build equipment for the production of high octane gasoline. He also gave a thorough explanation of his unusual incentive system.

J. E. Cain, Executive Vice-President of P. R. Mallory & Co., Inc., acted as master of ceremonies for the meeting that was concluded with an open forum in which Mr. Lincoln answered numerous questions from the audience.

Seated at the Speaker's Table, from the Left: R. D. Eaglesfield, Founder and Original Chairman of Indiana Section; W. R. Ball, Vice-President of Ball Bros., Inc., Muncie, Indiana; George N. Sieger, Midwest District Vice-President of American Welding Society; James F. Lincoln, President of Lincoln Electric Co., Cleveland, Ohio; and J. E. Cain, Vice-President and General Manager of P. R. Mallory & Co., Inc.

KANSAS CITY

The March meeting of the Kansas City Section of the AMERICAN WELDING SOCIETY was held Tuesday evening, March 7, 1944 at Fred Harvey's Pine Room.

The speaker of the evening was Mr. Paul H. Merriman, Electrical Engineer for the Glenn L. Martin Company, Baltimore, Maryland.

Mr. Merriman's subject "Engineering Aircraft Welding" concerned itself principally with the application of all types of welding, both ferrous and non-ferrous in the aircraft industry. Arc, gas and particularly resistance welding was covered very completely with both slides and motion pictures. Emphasis was placed on the necessity for rigid engineering control to realize the full potentialities of a welding process from the design of the part to the inspection of the finished article.

Mr. Merriman's manner of presentation made his talk very interesting to the members and guests in as much as he has a grand sense of wit which he injected into his talk at numerous times and interest never lagged.

LEHIGH VALLEY

The regular monthly meeting of this Section was held at the Hotel Bethlehem, Bethlehem, Pa., on Monday, April 3rd with 155 members and guests present. Chairman, H. W. Lawson presided.

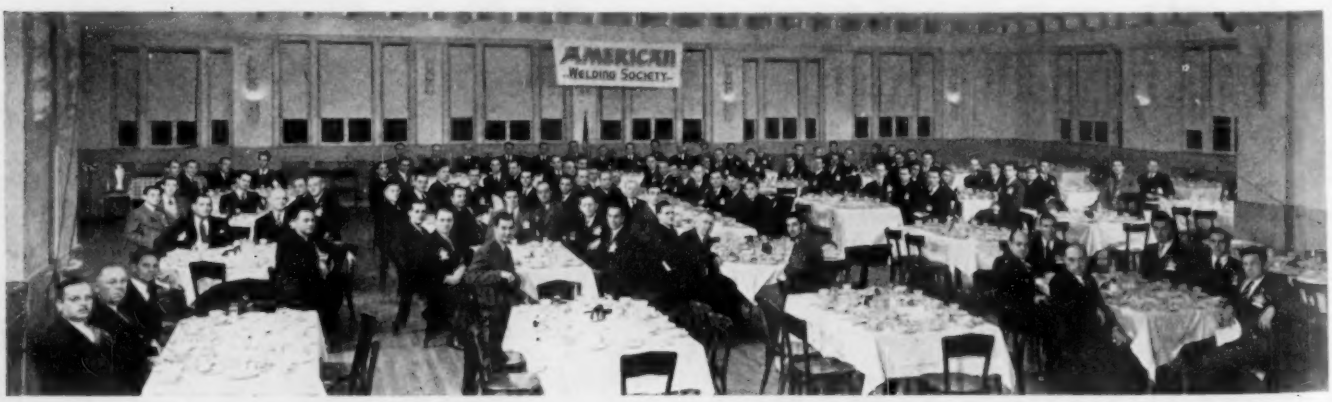
Preceding the regular technical meeting, official Navy sound pictures on, "The Life and Death of the Hornet" and "December 7th" were shown. The first film showed the life of "The Hornet" from its launching through its most important battles including the one resulting in its sinking. The picture "December 7th" is a recently released film which actually covers the sequel to December 7th. This film shows the repairing of the damaged ships which form the new Pearl Harbor Fleet.

The subject for the technical meeting was "Welded Castings in Shipbuilding." The speaker was R. A. Pomfret, Materials Engineer of the Shipbuilding Division, Bethlehem Steel Co. His talk was illustrated by lantern slides and covered the progress in the past ten years of the application of welding to large hull and machinery castings.

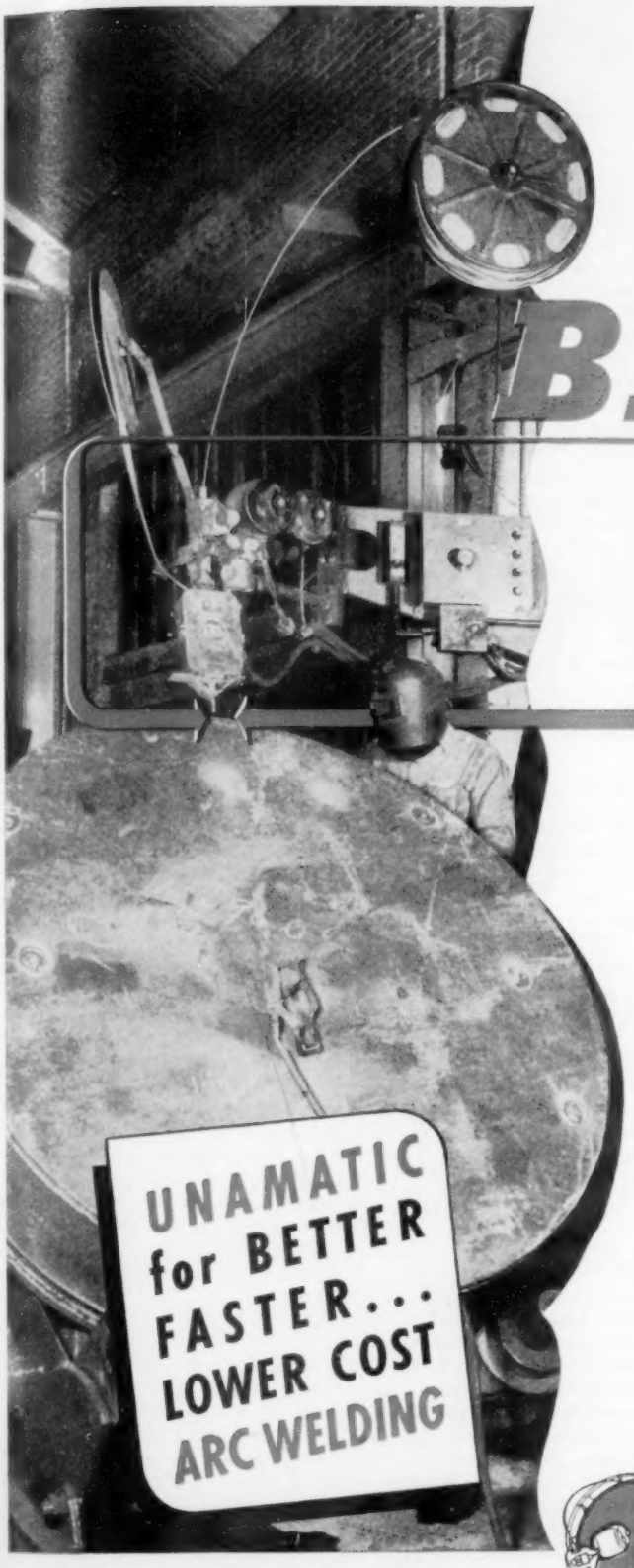
The following officers were elected for the coming Season: *Chairman*, J. W. Kenworthy, Mack Mfg. Corp.; *Vice-Chairman*, G. E. Doan, Lehigh University; *Secretary-Treasurer*, Julius Naab, Ingersoll-Rand Co.; *Incoming Directors*, R. L. Deily and P. H. Barron.

LOUISVILLE

The March Dinner Meeting of the Louisville Section was held on the 28th in the Ballroom of the Hotel Seelbach. Mr. R. E. Fritsch, Vice-President, Tube Turns, Inc. was Master of Ceremonies at the Dinner. Max Macon, formerly with the Brooklyn Dodgers was the dinner speaker. Mr. Macon spoke on "War Time Baseball." The technical address was given by Mr. Eric R. Seabloom, Su-



Recent Dinner Meeting of Louisville Section



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★ Establish the best welding procedure for a job and Unamatic will maintain this procedure as a constant process for each succeeding unit . . . because all functions are mechanically controlled!

Other reasons why Unamatic offers distinct advantages in quality when contrasted with manual welding: (1) with Una equipment, the highest skill of the experienced operator becomes part of each weld; (2) a continuous pass of uniformly high quality can be maintained; (3) heat distortion can be minimized on certain assemblies through the use of dual heads working simultaneously from both sides of the unit; (4) making the work easier for the operator by reducing strain contributes to higher quality.

Write today for complete information on how to obtain better, faster, lower cost arc welding with Unamatic. One of our experienced field engineers will be glad to discuss the application of Unamatic to your production . . . without obligation, of course.

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pervising Engineer, Research and Development Labs., Crane Company. Mr. Seabloom's talk "Application of Fusion Welding to Pressure Piping, Valves and Fittings" was illustrated with lantern slides. His subject was quite broad in scope and covered such items as design of component parts, welding techniques, code requirements, pipe headers and their reinforcements, and many other items. A lively discussion followed.

The April meeting held on the 10th in the Auditorium of the Speed Scientific School, University of Louisville, was addressed by Harry W. Pierce, Assistant General Manager, New York Shipbuilding Corp., who spoke on "Arc Welding Sequences of Ship Hulls."

MILWAUKEE

Dinner as usual preceded the monthly meeting of the Milwaukee Section held on March 24th at Cudworth Post, American Legion, Mr. R. David Thomas, Jr., Director of Research and Engineering, Arcos Corp., presented the Welding Address on "Problems in Stainless Arc Welding."

MOBILE

Mr. C. J. Holslag, President of Electric Arc, Inc., addressed the February meeting of this Section on the subject "Induction Preheating for Arc Welding." This was the same subject delivered before the Canadian Welding Society in Toronto.

Mr. W. W. Tieman, Testing Engineer for Gulf Shipbuilding and Mr. W. E. Ryan of the Alabama Dry Dock Co. were the speakers at the March meeting held at the Admiral Semmes Hotel.

NEW JERSEY

The regular monthly meeting of the New Jersey Section was held on March 21st at the Essex House, Newark. Dinner as usual preceded the meeting. An "Information Please" Session was held between 7:45 and 8:15 and Mr. K. M. Spicer Welding Technician of the International Nickel Co., was present to answer questions raised.

A three-real film "Copper Mining in Arizona" was shown through the courtesy of the U. S. Bureau of Mines.

"Welding of Copper Base Alloys," was presented by Mr. J. J. Vreeland of the Chase Brass and Copper Company. Mr. Vreeland discussed the methods of welding copper, copper alloys, two groups of brasses and various types of bronzes.

"Carbon-Arc Welding of Naval Brass" was presented by Mr. Hilo of Foster Wheeler Corp.

Both addresses were well received by the 124 members and guests present.

NEW YORK

The New York Section held its regular monthly meeting on Monday, April 10th, at the Engineering Societies Building. Mr. W. A. Howard, Assistant Engineering Supervisor, Socony Vacuum Oil Corp., Brooklyn, N. Y., presided as Technical Chairman.

Speaker for the evening was G. O. Hoglund, Aluminum Company of America, New Kensington, Pa. Mr. Hoglund's talk consisted of a general review of commercial methods for welding and brazing aluminum alloys as well as current practices for gas welding, metal and carbon arc welding, spot and seam welding, and furnace and torch brazing. His talk was illustrated with lantern slides. In addition, welded and brazed parts were exhibited showing the quality achieved in welding aluminum assemblies when these processes are employed. Mr. Hoglund's talk was extremely interesting and well received by the audience.

At the conclusion of Mr. Hoglund's talk, the picture "How To Do It" was shown. This picture, sponsored by the Aluminum Company of America, covered the gas welding, arc welding, resistance welding, and brazing of aluminum alloys.

The evening opened with a regular half-hour question and answer period which was conducted by H. R. Morrison, The Linde Air Products Company, N. Y.

The meeting was attended by Mr. F. C. Fyke, Vice-President of the New York-New England District of the AMERICAN WELDING SOCIETY, who spoke briefly on some of the activities and aims of the AMERICAN WELDING SOCIETY.

NORTHERN NEW YORK

The Northern New York Section held its February meeting on the 24th at the Locomotive Club Schenectady. A motion picture "To Each Other" was shown immediately after dinner.

Dr. William G. Theisinger of Lukenweld, Inc., presented a very practical talk on "Steels for Welding" giving the relative value and characteristics of the three main classes of steels. A film "The World's Largest Plate Mill" was also shown in connection with the talk.

The March 23rd meeting was addressed by Mr. H. O. Klinke of the Republic Aviation Corp., who spoke on "Welding in the Aviation Industry." A film "Aircraft Welding" was also shown.

NORTHWEST

Mr. John E. Ponkow, Chief Electrical Engineer of the Federal Machine & Welder Co., spoke on "Resistance Welding" at the March 23rd meeting of the Northwest Section held at Coffman Memorial Union, University of Minnesota. Mr. Ponkow covered in general terms, spot, seam and flash welding, the latest information on power requirements for various types of welding loads, and the application of series capacitors to various types of welding machines. A number of slides were shown and were followed by a sound film "Aircraft Production Procedure Through Aircraft Welding."

LaMotte Grover, welding engineer, Air Reduction Sales Company, New York, discussed "Analysis of Structural Design" at the last meeting, April 19th, in the welding engineering course conducted by the Northwest Section, in which he covered structural bridge and ship welding design.

The meetings, subjects and speakers in the course were:

March 27th: "Oxyacetylene Cutting and Welding," by Frank McGuire, Jr., Division Service Engineer, The Linde Air Products Company, Chicago.

April 3rd: "Fundamentals of Welding."

April 4th: "Factors Involved in Low Cost Welding," by W. J. Conley, consulting engineer, The Lincoln Electric Company, Cleveland.

April 17th: "Analysis of Machine Design" by John Mikulak, mechanical engineer, Electric Machinery Mfg. Co. Minneapolis, and chairman of the Section.

The course aroused much interest and was well attended by members, without any change, non-members paying an enrollment fee of $2.00. All meetings were held at the Coffman Memorial Union, University of Minnesota.

PHILADELPHIA

At the regular monthly meeting held March 20th, the Chairman, A. J. Raymo of the Nominating Committee submitted the following:

To serve for one year: *Chairman*, G. R. Johnson, District Manager, Lincoln Electric Co.; *Vice-Chairman*, A. A. Holzbauer, Asst. Welding Engr., Sun Shipbuilding & Dry Dock Co.; *Treasurer*, R. D. Thomas, President, Arcos Corp.; *Secretary*, K. W. Ostrom, Field Engineer, Arcos Corp.

To serve on Executive Committee for three years: H. J. Irrgan, W. K. Mitchell & Co.; O. C. Frederick, General Electric Co.; W. B. Brooks, Cramp Shipbuilding Co.

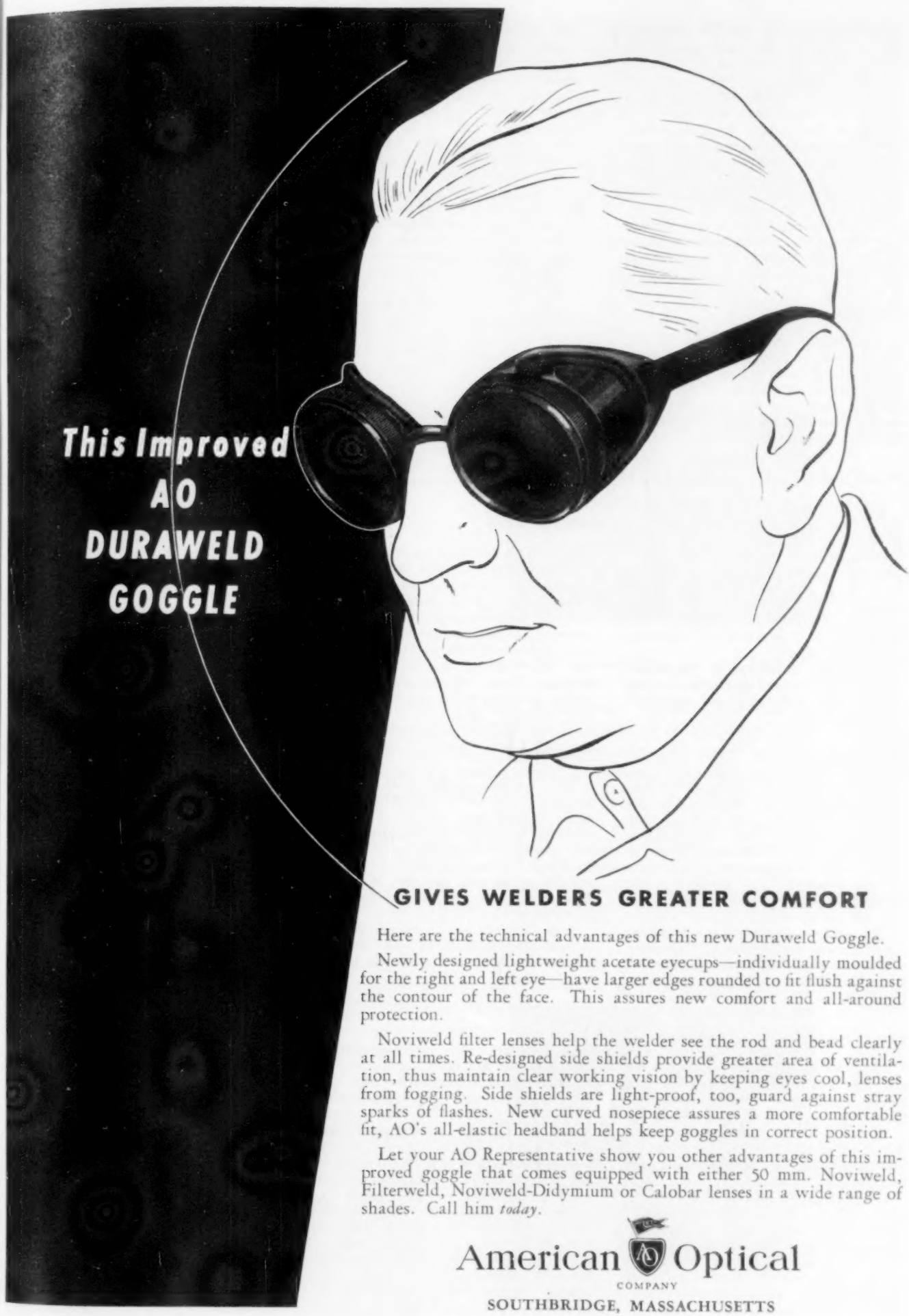
There being no other regular or special nominees these men were dully elected at the April meeting.

The technical discussion at the March meeting was of the open forum type with "Alloy Steel Welding" as the subject. The speakers were Walter J. Brooking of R. G. LeTourneau Co., George Mikhalapov of the National Research Council and R. D. Thomas, Jr., of Arcos Corp. Each of these men gave a short talk on a different phase of alloy welding, and then, collectively, spent over an hour answering many interesting questions. This was one of the most successful meetings of the year with over 200 members in attendance.

The Section was again honored by the presence of District Vice-President H. W. Lawson, who attended both the meeting of the Executive Committee and the regular meeting.

On March 31st, the Section held another one of the popular panel discussions that are sponsored jointly oy the local Section and the War Production Board; the subject was "Tool Repair and Maintenance Welding." The speakers, representatives of Welding Equipment & Supply Co., and Handy & Harman gave exceptional presentations of their subject matter, and supplemented it with samples and moving pictures. The attendance at this meeting was 60, most of whom were welding foremen and supervisors.

The Annual Meeting was held on April 17th, when the new officers were installed by retiring chairman, Harry W. Pierce. Mr. Pierce was congratulated upon his fine leadership for the past year.



GIVES WELDERS GREATER COMFORT

Here are the technical advantages of this new Duraweld Goggle.

Newly designed lightweight acetate eyecups—individually moulded for the right and left eye—have larger edges rounded to fit flush against the contour of the face. This assures new comfort and all-around protection.

Noviweld filter lenses help the welder see the rod and bead clearly at all times. Re-designed side shields provide greater area of ventilation, thus maintain clear working vision by keeping eyes cool, lenses from fogging. Side shields are light-proof, too, guard against stray sparks of flashes. New curved nosepiece assures a more comfortable fit, AO's all-elastic headband helps keep goggles in correct position.

Let your AO Representative show you other advantages of this improved goggle that comes equipped with either 50 mm. Noviweld, Filterweld, Noviweld-Didymium or Calobar lenses in a wide range of shades. Call him *today*.

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The inception and marked success of the panel discussions were largely the result of Mr. Pierce's efforts.

W. J. Conley of The Lincoln Electric Co. gave a fine talk on "Engineering Control of Production Welding," and showed by means of slides and samples how proper engineering can reduce costs and increase production on fabricating weldments.

The subject of the next regular meeting of the Section o be held May 15th will be "Some Developments in Gas-Shielded Arc Welding." The speaker will be R. F. Wyer, Application Engineer for the General Electric Co.

PORTLAND

The first meeting of the Portland Section was held on March 16th at the Multnomah Hotel and was a real success. There was an attendance of 97 at this meeting, and from the enthusiasm and keen interest displayed at this meeting, the Section is quite optimistic.

PUGET SOUND

The March meeting of the Puget Sound Section was held on the 29th at Gowman Hotel, Seattle. Mr. Art Webster of Webster Welding, spoke on the subject "Repair and Maintenance Welding as Done in a Job Shop." Professor Joe Daniels of the University of Washington presented an outline of the ground covered by the course "Iron and Steel," available at the University.

Mr. Glen Hammersberg, Education Committee Chairman, presented an outline of courses and educational opportunities now available.

ROCHESTER

A joint meeting of the Rochester Section of the A.W.S. and the American Society for Metals was held on April 10th. Dinner at the Rush Rhees Library Cafeteria, University of Rochester, preceded the meeting. A Coffee Talk "Progress of Future Aviation" was given by Mr. Richard Barton, President of Rochester Aeronautical Corp.

The technical meeting was held in the Lower Strong Auditorium of University of Rochester. Mr. William J. Conley, Consulting Engineer, The Lincoln Electric Co., spoke on "Production Welding."

SAN FRANCISCO

The February Meeting of the San Francisco Section was held at Angelo's Ball Room, Emeryville. There were approximately 150 members and guests present.

Mr. W. J. Miskoe, Manager, The Lincoln Electric Company, Australia, gave a very interesting talk on the progress of welding in the Antipodes.

The Nominating Committee announced the nomination of the following members as officers for the fiscal year: *Chairman*, C. Doggett, Moore Dry Dock Co. *Vice-Chairman*, L. Berner, Joshua Hendy Iron Works; *Treasurer*, H. W. Saunders, Air Reduction Sales Co.; *Secretary*, R. E. Labah, Victor Equipment Co.

Due to pressure of business, Mr. R. O. Schiebel, Jr. of Magnaflux Corporation was unable to be present, but sent his associate, Mr. Grey, in his place. Mr. Grey's talk on Magnaflux operation was very interesting and enlightening to all those present.

The meeting closed with the showing of the motion picture "The Capture of Tarawa and Bismark Convoy."

The March 31st meeting was a tour of inspection of the plants of the Wooldridge Manufacturing Company and the Joshua Hendry Iron Works in Sunnyvale, California. Dinner was served to the members and guests in the cafeteria of the Joshua Hendy Iron Works from 7:00 to 8:00 P.M. Immediately after dinner, they proceeded to the Wooldridge plant where they were permitted to watch the welding of the gears and the gear reduction case of the Turbine engines manufactured by this company.

Following this, the members and guests returned to the Joshua Hendy Plant where arrangements were made for a guide to conduct them through the plant. Here they observed the machining and assembling of gears and gear reduction case.

SOUTH TEXAS

The March 16th meeting of this Section was held at the Taylor School, where members and guests visited the welding clinic where there were several demonstrations at one time. Mr. George Steffan presented a picture showing how to rework high speed, tool steel dies, punches, etc. Mr. E. B. White, Castolin Eutectic Welding Alloys, showed slides and discussed problems concerning low temperature welding.

SYRACUSE

The Syracuse Section held its April meeting on the 13th at the Syracuse Museum of Fine Arts. Mr. R. T. Pursell, Welding Engineer, Worthington Pump and Machinery Co., spoke on "Non Destructive Testing Methods." A twenty minute sound film on the Magnaflux Method of Inspecting Airplane Parts was also shown.

May 11th will be the date of the first Annual Meeting of the Syracuse Section. Dinner and Entertainment is planned for members only.

TOLEDO

On February 9th a joint meeting was held with the American Society of Tool Engineers at the Toledo Yacht Club. Total attendance numbered approximately 150. A dinner preceded the meeting. Mr. J. W. Conley, Consulting Engineer with Lincoln Electric Company, Cleveland, Ohio, gave a talk on "Welding of Jigs and Fixtures." Motion pictures on welding procedures were also shown.

The Coast Guard Ice Breaker "Mackinaw" was launched on March 11th. In spite of sub-zero temperature and icy streets, a large crowd gathered to watch the side launching of this unusual all-welded, all-steel boat. Several of the members of the Toledo Section had a great deal to do with the design, as well as the fabrication of the "Mackinaw."

The March 21st meeting was held at the Secor Hotel. Mr. G. E. Bellew, foundry specialist from the New York office of Air Reduction Sales Company gave a very interesting and educational talk, illustrated with slides, on "Oxyacetylene Practice in Steel Foundries." The subject covered cutting off risers, washing, cleaning, gouging of surplus metal on steel castings, with specially constructed acetylene torches. This work formerly had to be done with chisels, often at a higher cost and many more man hours.

WASHINGTON, D. C.

The D. C. Chapter of the AMERICAN WELDING SOCIETY held its fifth meeting of the '43, '44 season Tuesday, February 22nd, in the Pepco Auditorium. Mr. C. E. Jackson, chairman of the meeting, welcomed the largest meeting audience in many years who had come to hear Commander J. F. Jelly, U.S.N., Deputy Director, Construction Dept. His subject was "The Work of the Seabees and Its Relation to Welding and Engineering."

The Commander traced the organization of the Seabees from its birth shortly after Pearl Harbor up through the present day where their work now takes them with the fleet to distant atolls, beach heads, islands and mainlands to establish bases, build roads, the utilities, docks and wharves, warehouses and all the installations needed to support our fleet and air operations.

This youngest of all branches of the armed services had no storied tradition when they began, but they have now. It's a rugged tradition of adaptability, hard work, technical skill, determination and courage. They live up to their slogan "can do."

Two years ago the Seabees' authorized strength was 3300. Today the battalions are within close range of their new goal of 290,000 officers and men. Two-thirds of them have seen service overseas; the remainder will soon be on their way. Most of the enlisted men have volunteered. A surprising number, over the draft age, are veterans of the first World War.

Since most every Seabee is a specialist he puts that skill to use in a vital military assignment. Each battalion has a place for men skilled in 59 construction crafts.

Seabee training is vigorous. Marine instructors school the construction men, most of whom already have been hardened by long years of outdoor work, to defend themselves against attack from any quarter. They pass through 8 weeks of training at Camp Peary, after which they are ready to do a skilled building job and, if necessary, to fight shoulder-to-shoulder with the Marines and Army.

As skilled and well-trained as these men were, front line experience stressed the necessity for additional high-skilled units trained to break other kinds of advance base bottle-necks. At one time sixty-six cargo vessels were lying off a South Pacific Island, their valuable cargoes immobilized while hastily assembled unloading crews fell further and further behind. Mean

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while, despite all possible dispersal tactics, the ships were inviting targets for enemy bombers. That was the situation when a Seabee special battalion, trained in loading and unloading war material, arrived and quickly took over. Within a month the "Special" had emptied 31 vessels; today they are unloading ships as fast as they come in. With special training and an enthusiasm for their work these crews are a match for professional long shoremen at home.

The Marine divisions are almost never without a Seabee detachment. A construction battalion which operated under fire on Guadalcanal received a Presidential citation for its remarkable record. At Bougainville, Seabees cutting roads and trails were 700 yards ahead of the front lines at times.

Special detachments have been formed such as truck overhaul units, under water demolition units, oxygen generating plant units, pontoon assembly detachments, camouflage units, etc. Still another specialized outfit is the base maintenance unit whose function is to take over the maintenance of an advance base already in operation, thus freeing an entire battalion for further new construction.

The jobs of the Seabees are legion. Their exploits have been vividly dramatized in story and film. Henderson Field, started by the Japs but taken over by the Seabees and completed against a background of continuous air assault, was one of the first and perhaps the most famous project to bear the Seabees' trademark. There have been many others since; the Solomons, Salerno, Rendova, Aleutians North Africa, Gilberts and Marshalls to mention the more important.

Quick thinking and Yankee ability to get the job done characterizes all Seabees no matter what problem they face. They have repaired airplanes, welded a new stern on a damaged warship, made emergency repairs to an aircraft carrier under fire and many other equally brilliant things not strictly in their usual line of duty. In one case, they were called upon to make emergency repairs on a propeller, since the ship repair crew was unable to remove the 2000 lb. screw from the ship because of lack of equipment. Seabees, however, used their bull-dozers to haul the stern of the ship up on the beach at low tide and while astonished ships' officers looked on, Seabees used a small charge of dynamite under mud and sandbags to blast the propeller loose. They then carted it off triumphantly to their improvised repair shop for a successful overhauling.

The Advance Bases constructed by the Seabees generally fall into two catagories—those for the support of ships and those for the support of aircraft. One of the larger Advance Bases already established has a capacity equal to some of our smaller continental Navy Yards. Such a base is capable of handling voyage repairs and minor battles repairs on all classes of naval vessels. Ship repair bases are usually provided with floating dry docks for underwater repairs. These are available in a range of sizes from the 100,000 ton Advance Base Section Dock to the small pontoon dry docks of 100 ton capacity for P.T. boats.

In order to reduce to consumption of critical materials and demands upon shipping, this general policy is followed in construction for Advance Bases:

(1) Construction is temporary and limited to essentials only.
(2) As much material as practicable is obtained in the vicinity of new bases.
(3) When practicable, labor, except skilled supervision, is obtained locally.
(4) Mechanical equipment furnished is limited to the bare essentials.

One of the reasons for the extraordinary success of the Seabees is that they are provided with sufficient equipment—of the best and most rugged types—to undertake any job that they may be called upon to do. For instance, each battalion is provided with 4 electric welding machines of the 300 Ampere gas engine driven type and 8 oxyacetylene cutting and welding outfits All are complete with necessary hand tools, spare parts, clamps, leads, helmets, gloves, goggles etc. In their initial outfit of material, the battalion carries 1250 lb. of assorted sizes of welding rod, 40 tanks of oxygen and 2 tons of carbide for their acetylene generators.

Welding has played an important part in the fabrication of Seabee equipment but its most outstanding contribution has been in the manufacture of the Navy pontoon. These units can be assembled overseas into barges, tugs, floating derricks, floating dry docks, fuel barges and causeways. This type of pontoon has been an outstanding contribution to amphibious warfare. Welding has permitted their manufacture in many small plants throughout the nation, with output limited only by the amount of steel plate that is allocated. Since the pontoons are bulky for their weight, they occupy much cargo space. In order to reduce this, several Seabee pontoon assembly detachments have been formed. Modern welding shops, using production line methods, have been set up on tropical islands and turn out completed pontoons as rapidly and efficiently as established industrial plants on the mainland.

In his closing remarks, Commander Jelly stated that more and more frequently the word "Seabees" crops out in news dispatches as fresh invasions and advances are launched. With United Nations now definitely on the offensive the frequency of these stories can be expected to increase. He hoped that as the audience read them they would take pride in these construction men who are making such an outstanding contribution toward that final victory.

A motion picture, "Navy Fighting Construction Men the World Over," was shown by George Knox, of the Navy Department. The film had a prologue and epilogue by Vice Admiral Ben Moreell, Chief of the Bureau of Yards and Docks.

An appreciative audience applauded the speaker loudly and long.

WESTERN MASSACHUSETTS

March Meeting Held at the Holyoke Trade School at 8:30 P.M. on March 29, 1944. The chairman, Mr. Emery opened the meeting at 8:30 P.M. welcoming 41 members and guests in attendance.

In a short business meeting, a motion was made by Mr. Gamache to amend the by-laws, changing the annual meeting date from September to May. This motion was approved for balloting. Next, a presentation of $5.00 in war savings stamps was made to Mr. Raymond Peltier for his prize paper on "Aluminum Spot-welding Tips" submitted in the first prize contest.

Proceeding to the technical portion of the program, Mr. Emery introduced the speaker for the evening, Mr. Bent Laune, Eastern Sales Manager of the Castolin Co. Speaking on "Low Temperature Welding," Mr. Laune cited several interesting applications of this new method with emphasis on casting repairs, tool and die reclaiming. In the lively question period that followed, Mr. Laune discussed matters of technique, preheat, strength and other important aspects of low temperature welding.

At the conclusion of this discussion, our chairman expressed the appreciation of the section for Mr. Laune's talk.

As a final feature, the film called "The Grinding Wheel" was shown through the courtesy of the Norton Company. The film gave some interesting tips on maintenance and use of grinding wheels.

The meeting was adjourned at 10:10 P.M.

WESTERN MICHIGAN

A very excellent talk was delivered by Mr. Thos. J. Defoe, Defoe Shipbuilding Co., at the March 27th meeting of the Western Michigan Section. Mr. Defoe's subject was "Welding in Modern Shipbuilding" and was beautifully illustrated with some colored movies which showed the ships being rolled over from the upside down position and also some good shots of an actual launching.

Officers of the Section are: *Chairman*, C. Lanphear; *Vice-Chairman*, F. E. Thompson, Jr.; *Secretary-Treasurer*, R. D. Layman; *Executive Committee*, W. G. Findoff, W. C. McLott, E. M. Sharp, I. C. Hepfer, W. J. Edbrooke, A. Bond; *By-Laws Committee*, J. Monahan, A Vander Henst, R. Ogden.

WICHITA

Mr. Paul H. Merriman, Welding Engineer of The Glenn L. Martin Co., was the guest speaker at the March 8th meeting held in the Empire Room of the Allis Hotel. Mr. Merriman's subject was "Rigid Engineering Control in Aircraft Welding." His talk was accompanied by films and slides. About 130 members and guests attended this very interesting meeting.

The April 5th meeting held in the Aviation Room of the Allis Hotel was addressed by Mr. J. E. Dato, Process Engineer, The Linde Air Products Co. His subject was "Specialty Welding and Unionmelt." This was also a very interesting meeting. The talk was illustrated with a moving picture. Mr. Dato also had some synthetic sapphires of various colors. About fifty members and guests were present.

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United States Steel Supply Company, Chicago, *Warehouse Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

List of New Members

March 1 to March 31, 1944

BOSTON

Bryan, Emmett W., Sr. (B), The Lumsden & Van Stone Co., 426 First St., Boston 27, Mass.
Burton, R. F. (C), Lumsden & Van Stone Co., 426 East First St., Boston 27, Mass.
Endicott, Benjamin F. (C), P. O. Box 11, Ocean Grove, Mass.
Smith, Ricker D. (C), 37 Laighton St., Lynn, Mass.

CANADA

Alison, Ronald G. (C), 1637 Erie St. E., Windsor, Ont., Canada.

CHATTANOOGA

Alverson, Ben H. (C), Jones & Sylar Supply Co., Box 4037, Chattanooga, Tenn.
Holland, R. S. (C), National Cylinder Gas Co., 1329 Chestnut St., Chattanooga, Tenn.
McKinney, M. O. (C), General Electric Co., 832 Georgia Ave., Chattanooga, Tenn.
Rankin, Arthur L., Jr. (C), Cavalier Corp., 343 W. 1st St., Chattanooga, Tenn.
Sylar, Chas. A. (C), Jones-Sylar Supply Co., Box 4037, Chattanooga, Tenn.

CHICAGO

Adelsperger, Fred J. (C), 2317—169th St., Hammond, Ind.
Dunn, Gordon H. (B), 1026 Forest Hills Ave., Calumet City, Ill.
Gullickson, Lester D. (B), 443—165th St., Hammond, Ind.
Hawkins, R. L. W. (B), Harnischfeger Corp., 20 N. Wacker, Chicago, Ill.
Hough, Paul (C), 3015 Eschol Ave., Lion, Ill.
Miller, John L. (B), 4164 W. Cullom, Chicago 41, Ill.
Mueller, Thomas (B), 107 Warren St., Calumet City, Ill.
Murdoch, Robert H. (B), c/o Frank L. Wells Co., 5821—5th Ave., Kenosha, Wis.
Powers, Frank G., Jr. (C), 15306 Turlington Ave., Harvey, Ill.
Saboff, George (C), 4005 Fir St., East Chicago, Ind.

CINCINNATI

Crowe, Robert E. (B), 1911 Young St., Cincinnati 19, Ohio.
Webb, Trueman L. (B), 435 Probasco Ave., Cincinnati 20, Ohio.

CLEVELAND

Huddle, Berkley E. (B), Route 1, Nevada, Ohio.
Mueller, Robert E. (C), 1778 Rosedale Ave., E. Cleveland, Ohio.
Peseh, Fred (B), B. P. Welding-Blacksmithing, 3291 East 65th, Cleveland, Ohio.

COLORADO

Ford, Howard C. (B), 2916 W. 25th Ave., 9, Denver 11, Colo.

CONNECTICUT

Gilliland, N. B. (B), 4883 N. Main St., Stratford, Conn.

DETROIT

Forrester, William H. (B), 1228 E. Downey Ave., Flint, Mich.
Johnston, Daniel W. (C), 13611 Linnhurst, Detroit 5, Mich.
Poirier, George L. (B), 321 Auburn, Pontiac, Mich.
Rowland, S. B. (B), Route 6, Mt. Clemens, Mich.
Terry, Charles W. (C), The Elec. Storage Battery Co., 8051 W. Chicago Blvd., Detroit 4, Mich.

KANSAS CITY

Hausman, Paul G. (C), 2042 New Hampshire, Lawrence, Kans.

LOS ANGELES

Conklin, Charles F. (C), 10141 San Luis Ave., South Gate, Calif.
Craig, Robert E. (C), 5814 Santa Fe Ave., Los Angeles 11, Calif.
Dyer, Donald B. (C), 2407 Ashland Ave., Santa Monica, Calif.
Fallon, Clifford T. (C), Linde Air Products Co., 2305 E. 52nd St., Los Angeles, Calif.
Luttrell, William L. (C), 1112 E. 7th St., Long Beach, Calif.
Manning, Homor R. (C), 5415—9th Ave., Los Angeles, Calif.
McGinnis, David McKnight (C), General Petroleum Corp. of Calif., 2525 E. 37th St., Vernon, Calif.
Moore, George V. (C), 1325 S. Poinsettia, Compton, Calif.
Nix, H. S. (C), Western Pipe & Steel, Shipbldg. Div., P. O., Box 1621, San Pedro, Calif.
Oswalt, Donavan P. (C), 3130 Lynwood Rd., Lynwood, Calif.
Pryor, Jack (C), 1441 W. 216th St., Torrance, Calif.

LOUISIANA

Chambers, James W. (C), 2724 Amarillo St., Baton Rouge, La.

LOUISVILLE

Carver, Romie Lee (C), 1724 Oak St., New Albany, Ind.
Murner, Marshall B. (C), 211 W. Court Ave., Jeffersonville, Ind.
Ross, R. R. (B), 1202 Beech St., Louisville, Ky.
Snedegar, Charles (C), 217 E. High St., Jeffersonville, Ind.
Wilkinson, F. L., Jr. (B), Speed Scientific School, University of Louisville, Louisville, Ky.

MARYLAND

Johns, Lamar F. (C), 3 Sixth Ave., Baltimore 25, Md.
Oliver, Robert F. (C), 433 Overbrook Rd., Catonsville, Md.
Scally, Joseph L. (C), 3024 Barclay St., Baltimore 18, Md.

MILWAUKEE

Ahsinger, Louis (C), c/o Trackson Co., Milwaukee 1, Wis.
Claflin, Wayne E. (C), 3922A No. 15th St., Milwaukee 6, Wis.
Frank, Louis C. (C), c/o Trackson Co., Milwaukee 1, Wis.
Ingrelli, Cono (C), 1611 N. Astor, Milwaukee, Wis.
Leiser, Fred (C), c/o Trackson Co., Milwaukee 1, Wis.
Nielsen, H. Richard (C), 6214 W. Lloyd St., Wauwatosa, Wis.
Norton, Roy (B), Ampco Metal, Inc., 1745 S. 38th St., Milwaukee 4, Wis.
Reschenberg, Armin (F), 219 N. Brooks St., Madison, Wis.
Stevens, Charles N. (C), Milwaukee Boiler Mfg. Co., 1101 S. 41st St., Milwaukee 4, Wis.

MOBILE

Anderson, Shelby W. (B), 1456 Robert E. Lee Ave., Mobile 19, Ala.
Devine, Paul E. (B), Gulf Shipbldg. Corp., 209 Second St., Chickasaw, Ala.
Hill, H. (A), Gulf Shipbldg. Corp., P. O. Box 1365, Mobile 8, Ala.
Knight, Chester A. (B), Box 1296, Chickasaw, Ala.
Nelson, Braxton B. (C), Baldwin Co., Daphne, Ala.
Russell, E. S., Jr. (B), 805 Parham St., Mobile, Ala.

NEW JERSEY

Amman, Herman L. (B), 79 Greenwood Ave., Madison, N. J.
Bauer, G. W. (C), 417 Woodland Ave., Westfield, N. J.
Buczkoski, Bernard (C), 1064 Chester St., Hillside, N. J.
Fulton, John W. (C), A. & W. Engrg. Co., P. O. Box 135, Bayonne, N. J.
Geibel, Frederick T. (C), 168 W. 10th St., Bayonne, N. J.
Goehring, Frank (B), 665 Roosevelt Ave., Carteret, N. J.
Hall, Eric (C), Thermacote Co., 120 Arlington St., Newark, N. J.
Hook, Harold H. (C), 1028 Harding Rd., Elizabeth, N. J.
Koehler, A. F. (C), 314 East 201st St., New York, N. Y.
Koven, Gustav H. (B), Orchard Hill Farm, Green Village, N. J.
Laskowski, F. (C), 40 E. 15th St., Bayonne, N. J.
Lindsay, P. (C), 115 Elmwood Terrace, Linden, N. J.

Mackenzie, **Robert** (C), Tide Water Associated Oil Co., Foot—22nd St., Bayonne, N. J.
Morris, **Sidney** (C), Reliable Welding & Mach. Co., 477 Summer St., Patterson, N. J.
Lytwyn, **Andrew** (C), 519 Ave.E.,Bayonne, N. J.
Pelciotto, **Theodore** (C), 327—51st St., West New York, N. J.
Powell, **Elmer E.** (C), 545 William Penn Way, Rm. 1108, Pittsburgh 19, Pa.
Price, **John R.** (C), P. O. Box 21, Madison, N. J.
Reppen, **Irving** (B), Reppen Welding Wks., 189—8th Ave., Patterson, N. J.
Sayer, **Grover C.** (C), 815 Union Ave., Elizabeth 3, N. J.
Shoemaker, **E. H.** (C), 3944 Clay-Cut Rd., Baton Rouge, La.
Steinmetz, **Richard** (B), 334 Ashland Rd., Summit, N. J.
Walsh, **James** (B), 116 Union Pl., Ridgefield Park, N. J.
Webb, **Archer W.** (C), 1044 Park Ave., Plainfield, N. J.

NEW YORK

Carpenter, **John** (C), N. Y. Central R.R., 466 Lexington Ave., Rm. 1064, New York, N.Y.
Haas **Herbert** (C), Craftsmen Welders, Inc., 518 Columbia St., Brooklyn, N. Y.
Kushner, **Joseph** (B), Island Stamping Co., Inc., 620 Fulton St., Farmingdale, N. Y.
Landis, **G. A.** (B), 24 Whittier St., Lynbrook, L. I., N. Y.
LaVallee, **William P.** (C), Craftsmen Welders, Inc., 518 Columbia St., Brooklyn, N. Y.
Pribil, **Victor** (B), N. Y. Art Iron Wks. Co., 330 E. 26th St., New York, N. Y.
Pufahl, **Hans R.** (B), The Linde Air Products Co., 30 East 42nd St., New York, N. Y.

NORTHWEST

Hendrickson, **A. G.** (C), Harnischfeger Corp., 840 Lumber Exch., Minneapolis, Minn.
Johnson, **Erving G.** (C), Lake Crystal, Minn.

OKLAHOMA CITY

Cook, **J. Stine** (B), 329 N. W. 28th St., Oklahoma City, Okla.
Hughes, **Robert K.** (C), J. W. Blake, Box 1498, Oklahoma City 1, Okla.

OMAHA

Bornemeier, **Albert H.** (C), Glenn L. Martin Neb. Co., Wabash, Neb.

PEARL HARBOR

Andrade, **Antone, Jr.** (C), 1317 Dominis St., Honolulu 4, T. H.
Clancy, **Edward J.** (C), 1923 Kalakaua Ave., Honolulu, T. H.
Erickson, **T. Herman** (B), Shop 26, Pearl Harbor Navy Yard, T. H.
Jensen, **Robert L.** (C), 426—10th St., Naval Housing, Honolulu, T. H.
Jurczynski, **Stanley** (C), 1508 Kelaumoker St., Honolulu 4, T. H.
Kirchner, **Wilfred** (C), 1245 Wilder Ave., Honolulu, T. H.
Kortum, **Fred** (C), 253 Saratoga Rd., Honolulu 20, T. H.
Kruse, **August H. K.** (C), 1728-B Kaliki St., Honolulu, T. H.
Kunkel, **Leo C.** (C), 824—15th St., Cha 3, Honolulu 60, T. H.
Lorenz, **Carl** (C), Lunalilo Home Rd., Honolulu, T. H.
McCaw, **John** (C), P. O. Box 416, Naval Cantonment, Honolulu, T. H.
McFadden, **A. C.** (C), 231 North Dr., Navy Housing, Honolulu 50, T. H.
Rigdon, **Madison R.** (C), 304—6th St., Navy Housing, Honolulu, T. H.
Rodriques, **Arthur** (B), 1602 Mikahala Way, Honolulu, T. H.
Swords, **Edward W.** (C), 423-A Olahana, Honolulu, T. H.
Woods, **Norman J.** (C), 927 Prospect St., Honolulu 25, T. H.

PEORIA

Gregory, **Herbert F.** (C), 3809 Prospect Ave., Peoria, Ill.

PHILADELPHIA

Carson, **Harold V.** (B), Lukens Steel Co. & Subsidiaries, Coatesville, Pa.
Condon, **Wm. J., Lt., U.S.N.** (C), Office of Supervisor of Shipbldg., New York Shipbldg. Corp., Camden, N. J.
Dermond, **Louis** (C), 6307 Jackson St., Philadelphia 35, Pa.
Goshorn, **William W.** (C), Malvern, Pa.
Hendricks, **Henry P., Sr.** (C), 1609 Evans Ave., Prospect Park, Pa.
Houck, **Walter** (C), 2715 Swarts St., Chester, Pa.
Sanville, **Wilson B.** (C), 237 Wiltshire Rd., Upper Darby, Pa.
Silver, **Herman** (C), 1427 S. 6th St., Philadelphia 47, Pa.

PORTLAND

Allen, **Robert** (B), 3123 N. E. Bryce St., Portland 12, Ore.
Baird, **David J.** (B), 6727 N. Portsmouth, Portland 3, Ore.
Bennight, **Denver M.** (C), 610 W. 40th, Vancouver, Wash.
Bollinger, **Charles** (B), J. E. Haseltine & Co., S. W. 2nd Ave., & Ash St., Portland, Ore.
Bristoe, **John** (B), 11848 S. E. Rhone St., Portland Ore.
Burke, **E. J.** (B), Pacific Chain & Mfg. Co., 1901 N. W. Wilson, Portland, Ore.
Chatterton, **Paul W.** (A), J. E. Haseltine & Co., Portland, Ore.
Ellison, **John** (B), 521 N. E. Lawrence Ave., Portland 12, Ore.
Forslund, **Erwin E.** (B), J. E. Haseltine & Co., S. W. 2nd Ave. & Ash St., Portland, Ore.
Hansen, **Lewis J.** (B), 7115 N. E., Roselawn, Portland 13, Ore.
Huxtable, **Charles R.** (B), American Bureau of Shipping, 722 Board of Trade Bldg., Portland, Ore.
Maloney, **Tom J.** (B), J. E. Haseltine & Co., S. W. 2nd Ave. & Ash St., Portland, Ore.
McCann, **James F.** (B), American Bureau of Shipping, 722 Board of Trade Bldg., Portland, Ore.
Milulic, **Anthony J.** (B), Schmitt Steel Co., 2407 N. W. 28th Ave., Portland 10, Ore.
Montgomery, **Clarence S.** (B), 3403 N. E. 76th Ave., Portland, Ore.
Smith, **Wilbur C.** (C), 122 Center St., Oregon City, Ore.
Thompson, **Herbert B.** (B), Route 1, Box 168, St. Helens, Ore.
Voshell, **L. B.** (B), 1814 N. Church St., Portland, Ore.

PUGET SOUND

Miller, **Frederick G.** (C), 1204 Marion St., Seattle 4, Wash.
Wood, **Wm. P.** (B), Route 6, Box 247, Tacoma, Wash.

ROCHESTER

Gross, **Donald B.** (C), 4747 St. Paul Blvd., Rochester, N. Y.

ST. LOUIS

Brown, **Earl H.** (C), Box 473, Grayville, Ill.
Dumbleton, **Harry J.** (B), American Bureau of Shipping, 1435 Boatmen's Bank Bldg., St. Louis 2, Mo.
Guirl, **Howard P.** (B), Airtherm Manufacturing Co., 700 S. Spring Ave., St. Louis, Mo.
McDonald, **Harold M.** (C), 100 N. Wood River Ave., E. Alton, Ill.
Morgan, **Harry** (C), 2524A Coleman, St. Louis, Mo.

SAN FRANCISCO

Basich, **John R.** (B), Western Pipe & Steel Co., S. San Francisco, Calif.
Birdsell, **Harold J.** (A), c/o Welding Service Sales, Inc., San Carlos, Calif.
Brink, **H. S., Jr.** (B), 1304 Jenevien Ave., San Bruno, Calif.
Brubaker, **Ralph T.** (C), Western Pipe & Steel Co., Rm. 108, Administration Bldg., c/o H. S. Brink, S. San Francisco, Calif.
Day, **Donald S.** (B), 1124 Lawton St., San Francisco 22, Calif.
De Martini, **Edward** (C), 514 Clipper St., San Francisco, Calif.
Forrer, **H., S.F. 1/C,** (C), F. P. O., San Francisco, Calif.
Hurley, **William H.** (C), 97 Railroad Ave., Willits, Calif.
Nata, **William R.** (B), 575 Noe St., San Francisco, Calif.
Puccinelli, **George** (B), 3055 Laguna St., San Francisco, Calif.
Tanner, **Paul F.** (B), F. F. Tanner Co., 888 Folsom St., San Francisco 8, Calif.

SOUTH TEXAS

Daigle, **Lloyd L.** (B), Big Three Welding Equipment Co., P. O. Box 3047, Houston, Tex.

SYRACUSE

Bessey, **J. M.** (B), Cortland Welding Compound Co., Cortland, N. Y.
Currier, **Raymond C.** (C), 219 Maplehurst Ave., Syracuse, N. Y.
Curtis, **L. W.** (C), R. F. D. 1, Black River, N. Y.
Farnam, **Gordon** (C), Cayuga St., Fulton, N. Y.
Groves, **Elwin C.** (C), New York Air Brake Co., Starbuck Ave., Watertown, N. Y.
Groves, **Ernest** (C), Bentley Weldery, Inc., Box 1038, Syracuse 1, N. Y.
Horner, **Donald** (C), 415 Le Moyne Ave., Syracuse 8, N. Y.
Trexler, **Robert** (C), Plainville, N. Y.
Vautrin, **John** (C), 108 Ferguson Pk., N. Syracuse, N. Y.
Wood, **Harold** (C), Syracuse Supply Co., 314 W. Fayette St., Syracuse, N. Y.

TOLEDO

Smith, **John W.** (B), Route 2, Box 260, Wilford Dr., Toledo, Ohio.

TULSA

Wiley, **George Le Mar** (C), Box 226, W. Tulsa, Okla.

WASHINGTON, D. C.

Everett, Willard F. (C), 62 Washington St., Portsmouth, Va.
Stogner, William H. (B), 6005—43rd St., Hyattsville, Md.

WESTERN MICHIGAN

Artis, Paul M. (C), 1247 Ballard, Grand Rapids, Mich.
Baxter, H. J. (B), 1415 Burlingame S. W., Grand Rapids, Mich.
Edbrooke, W. N. (B), Haven-Busch Co., 502 Front Ave., N. W., Grand Rapids 4, Mich.
Findorff, William G. (B), Steel-Fabricating Co., 603 W. Grand Ave., Muskegon, Mich.
Garman, Glenn G. (B), Purity Cylinder Gases, Inc., Grand Rapids 3, Mich.
Lamphear, Carol (B), C. H. Dutton Co., 630 Gibson St., Kalamazoo, Mich.
Sweet, Howard W. (B), Purity Cylinder Gases, Inc., 574 Division Ave. S., Grand Rapids 3, Mich.
Whipple, E. Allen (C), 412—2nd Ave., Big Rapids, Mich.

WESTERN NEW YORK

Galvin, Harold E. (B), Galvin Machy. Sales Co., 1501½ Main St., Buffalo 8, N. Y.

WICHITA

Allen, Paul E. (C), Beech Aircraft Corp., Wichita, Kan.
Kirk, L. E. (B), Potwin, Kan.
Krupp, Walter H. (B), Route 1, Box 310, Wichita, Kan.

NOT IN SECTIONS

Marx, M. (C), Appin' Castle Hill Rd., West Pennant Hills, N. S. W. Australia.
O'Donnell, Bartholomew (C), Chambers Rd., Cape Elizabeth, Me.
Smith, Joseph T. (B), 120 Stafford Rd., Waddon, Croydon, England.
Woodman, George H. (C), 45 Newfoundland Rd., Cardiff, South Wales, Great Britian.

Members Reclassified

During Month of March

BOSTON

Chayka, Paul (from D to C), 708 Park Ave., Cranston 10, R. I.

CHICAGO

Youngquist, Gordon, (from D to C), 11111 S. Forrestville, Chicago, Ill.
Rhode, Maynard (from D to C), Maynard Rhode Welding Shop, 1025—10th St., Rockford, Ill.

CINCINNATI

Courtright, Walton K. (from D to C), 2127 Marker Ave., Dayton, Ohio.

DETROIT

Bower, Harold S. (from D to C), 34572 Sims, Wayne, Mich.
Goble, Dewey C. (from D to C), 2955 Blaine, Detroit 6, Mich.

LOS ANGELES

Harvey, Ivan M. (from D to C), 2424 W. Grand Ave., Alhambra, Calif.

MARYLAND

Fox, Clarence J. (from D to C), 2907 Dunran Rd., Dundalk, Md.

MOBILE

Collier, Michael O. (from C to B), Alabama Dry Dock & Shipbldg. Co., Shipbldg. Division, Welding Dept., Mobile, Ala.

NEW JERSEY

Laurinatis, J. (from C to B), 130 Fairview Ave., Boonton, N. J.
Plaskon, Edward W. (from D to C), 40 E. 41st St., Bayonne, N. J.

NEW YORK

Mann, John M. (from D to C), 2991 Quenton Rd., Brooklyn, N. Y.
Sabol, Henry E. (from D to C), 4107—53rd St., Woodside, L. I., N. Y.
Schwartz, David (from D to C), 7403—18th Ave., Brooklyn, N. Y.
Stoll, Harry (from D to C), 804 W. 180th St., New York, N. Y.

PORTLAND

Weil, Edward H. (from C to B), Lincoln Elec. Co., 660 N. Thompson St., Portland, Ore.

YORK-CENTRAL PENNA.

Bean, Willis E. (from D to C), 215 E. King St., York, Pa.
Theisinger, W. Gordon (from C to B), 104 S. 12th Ave., Coatesville, Pa.

NOT IN SECTIONS

Kelly, J. H. (from D to C), P. O. Box 487, Bristol, Va.
Kelly, R. M. (from D to C), 1133 S. Brighton St., Dallas, Tex.
Morrison, Charley (from D to C), Ralls, Tex.
Wolk, Leon, S.-Sgt. (from D to C), R.F.D. 3, Rockville, Conn.

INDUSTRIAL FLUOROSCOPY

X-rays are used in connection with films to obtain a picture—or a radiograph, as it is termed—or they can be focused on a screen impregnated with some salt such as zinc sulphide or calcium tungstate, which radiates visible light varying in intensity with the intensity of the X-rays received. This property is called fluorescing and the machine that makes use of it is a fluoroscope.

Fluoroscopic inspection has a very strong popular appeal. It is very attractive to speculate on the possibilities of having the work pass across a screen and instantly separate the good from the bad—no waiting for films to be developed and dried, no films at all, no dark room, no delay. Savings mount, costs go down, and for these reasons there have been many attempts to widen the field of application of the fluoroscope, but the stumbling block has always been lack of sensitivity for until very recently, a sensitivity of 15% was considered normal, 10% good, and under very unusual circumstances, 8% might be seen. Today, we know that these limits can be just about cut in half. In other words, a sensitivity of 5% or better can be counted on as a regular day in and day out production standard.

Considerably higher voltages are required on a fluoroscope than on a film. This is only to be expected because the time factor, which permits the effect of the X-rays to accumulate on film, is totally absent on the fluoroscopic screen. The screen shows only the instantaneous image. This limitation immediately translates itself into a limit of thickness that can be fluoroscoped because it is not practical to use a unit of more than 220 kv. or 250 kv. capacity for fluoroscopy. The reason for this limit is principally a matter of safety. As the voltage is increased over these limits, there must be more than a proportionate increase in the thickness of lead and lead glass of the viewing cabinet. Moreover, with fluoroscopy, the X-ray is left turned on for a much longer period of time than is the case with radiography, which increases the importance of providing adequate protection. The Kelly-Koett Industrial Laboratory at Covington, Ky. has found the practical limits to be approximately 2 in. of aluminum and approximately ½ in. of steel.

The fluoroscopic screen provides no permanent record. The results obtained are in what the observer sees and if a check is required, other means must be used.

The degree of success with fluoroscopy depends on personal factors to a greater degree than is the case with radiography.

A radiograph provides a picture in one plane only, but in a fluoroscope the part can be rotated which provides a third dimensions to definitely fix the location of the defect. Also, certain types of defects, such as cracks and fissures will only appear on a film if the part is so placed that the plane of the crack lines up with the direction of the X-ray beam. The chances are very slim indeed of being able to place a part on film in exactly such a position, but in a fluoroscope the part can be twisted and turned until—suddenly—there it is.